Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MAY, 1951

TECHNOLOGY DEPT.

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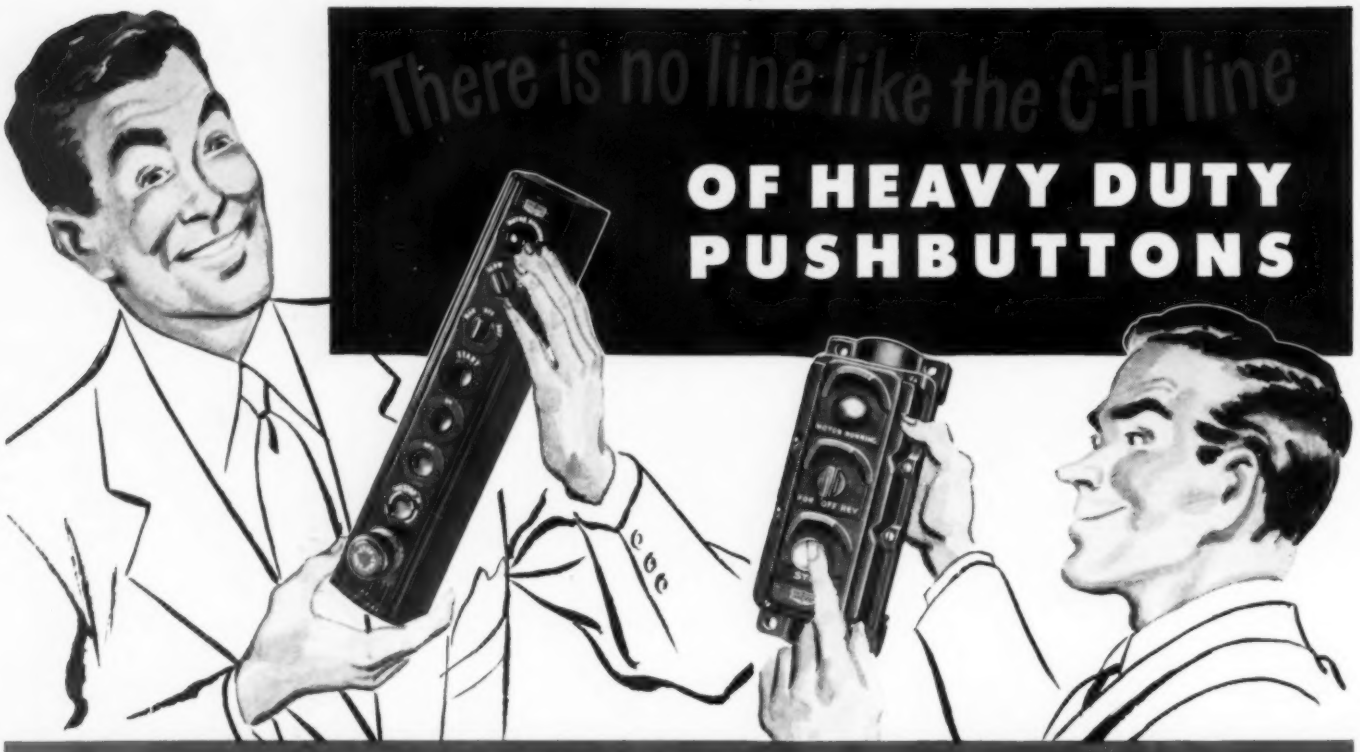
WEAN STEEL MILL *Equipment is*

WORLD WIDE

The WEAN ENGINEERING COMPANY, INC.
WARREN, OHIO
SPECIALISTS IN SHEET, TIN and STRIP MILL EQUIPMENT



EVERY TYPE OF OPERATOR

Plain Button Base Mounting | Plain Button One Hole Mounting | Maintained Contact Base Mounting | Latch Down Plain Button | Mushroom Head Base Mounting | Mushroom Head One Hole Mounting | Rotary Selector 2 or 3 Position | Maintained Contact One Hole Mounting | Oil-Tight One Hole Mounting | Indicating Light One Hole Mounting | Latch Safe Base Mounting

EVERY TYPE OF STATION

General Purpose | Oil Tight | Flush Mounting | Water and Dust Tight | Oil immersed, Hazardous Class I and II

EVERY TYPE OF CIRCUIT COMBINATION . . . 32 IN ALL

The Cutler-Hammer line of heavy duty pushbuttons offers the widest selection, by far, of operators, elements, stations and circuit combinations. This line has the unique distinction of being designed and engineered from the very start for such broad coverage of needs . . . through the development of a fundamentally correct contact mechanism capable of being incorporated into diversified types of elements, an equally modern and extensive line of operators . . . and a maximum number of circuit combinations.

As a result, users have gained such advantages as: complete interchangeability, uniformity of design and performance, exceptionally long life, frequently the elimination of any need for additional relays, interlocks and the like, ease of installation through visible contacts which facilitate circuit identification and terminals which are unusually large and accessible, and attractive appearance. All basic elements have successfully undergone Underwriters' tests. Here is a line attractive to machine designers, machine buyers and maintenance men alike. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 28, No. 5.

if you produce, process or fabricate

STEEL

COPPER

ALUMINUM

BRASS

you can use mills and machines made by AETNA-STANDARD

Products

Seamless Tube Mills
Piercing Mills
Plug Mills
Reelers
Sizing Mills
Reducing Mills
Continuous Butt Weld Pipe Mills
Continuous Seamless Tube Rolling Mills
Levellers
Shears
Slitters
Tension Reels
Upcoilers
Pilers
Side Trimmers
Stretcher Levellers
Pay-off Reels
Down Coilers
Coil Breakers
Side Trimming Lines
Slitting Lines
Scrubbing and Drying Lines
Continuous Strip Galvanizing Lines
Sheet Galvanizing Lines
Continuous Strip Long Terne Lines
Continuous Electrolytic Tinning Lines
Hot Dip Tinning Equipment
Cutting-off Machines
Continuous Pipe Galvanizing Equipment
Mill Tables
Cooling Beds
Drawbenches
Bar Turning Pointers
Hydraulic Squeeze Pointers
Wire Pointers
Bending Machines
Wire Drawing Machines
Rolling Mill Rolls

aetna-standard

THE AETNA-STANDARD ENGINEERING COMPANY · YOUNGSTOWN, OHIO

Plants in Warren, Ohio · Ellwood City, Pennsylvania

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

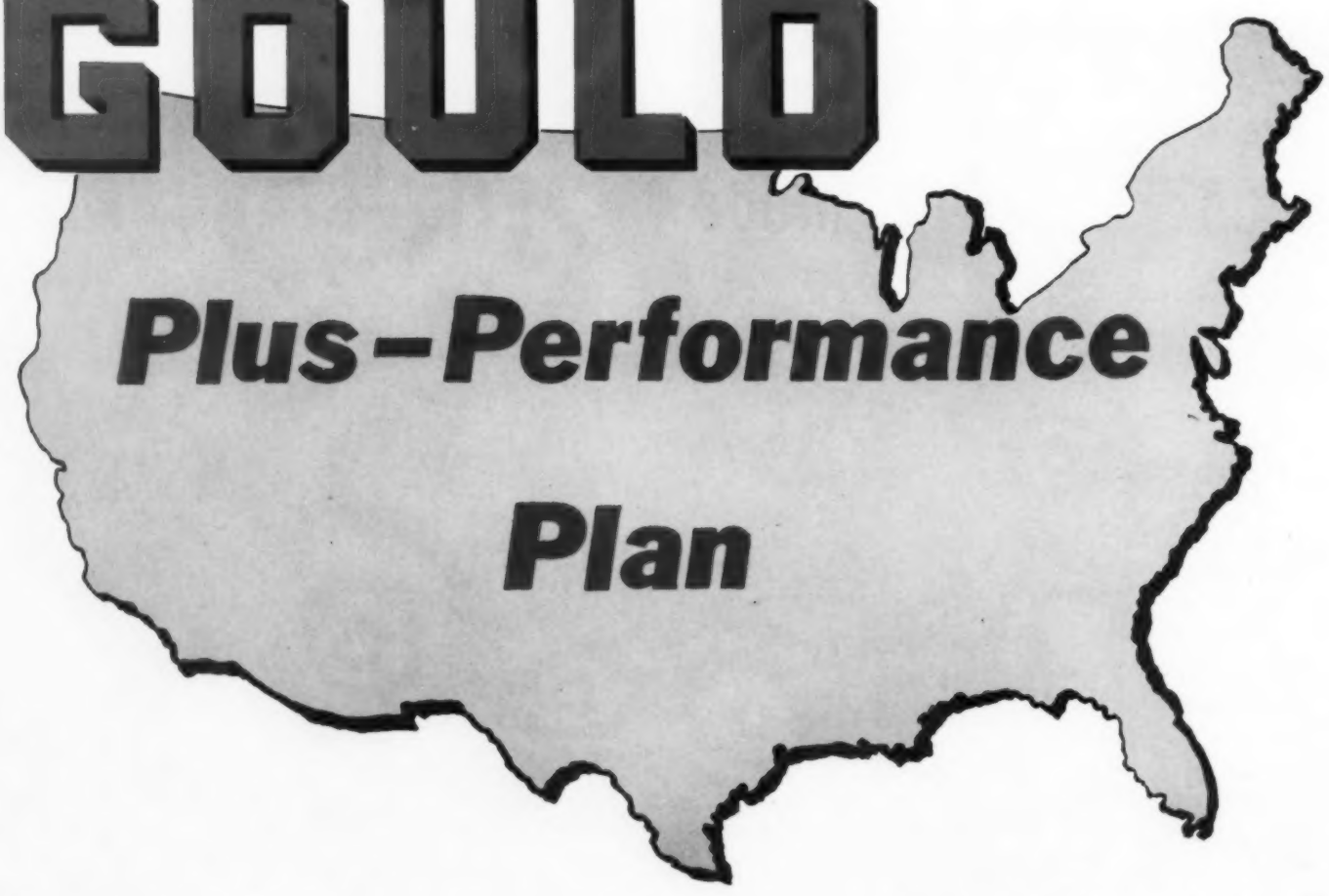
Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Here's Help

You demand more and more from your batteries as industry strains its facilities for defense. To help you get more out of these essential tools of production—to choose, use, handle and maintain your batteries without waste— Gould announces the

GOULD



You Need NOW!

Battery performance can be improved as much as 50%* if these eight points are put into practice:

1. **Buy Your Batteries to Fit the Job.** Purchase of oversized or undersized batteries wastes money, materials and manpower.
2. **Install Your Batteries Correctly.** Connect them properly, ventilate adequately and handle according to printed instructions.
3. **Use Your Batteries Within Designed Capacities.** Overdischarge cuts down battery performance.
4. **Charge Your Batteries Properly.** Use recommended rates of initial, finish and float charges.
5. **Maintain Your Batteries Systematically.** Organize a preventive maintenance program.
6. **Inspect Batteries Periodically.** Tighten loose connections and replace worn cables.
7. **Test Your Batteries Regularly.** Keep a record of cell readings—know the condition of your batteries at all times.
8. **Replace When Necessary.** When you know the condition of your batteries, you can place your orders far enough ahead to insure continuous service.

GOULD'S PLUS-PERFORMANCE PLAN is designed to help you conserve and extend your essential battery power. It is a complete, integrated system of manuals, articles, specifications, bulletins, record cards and charts which give you information on every one of these eight points—explaining and illustrating how to choose, use, install, charge, maintain, inspect and test.

**From tests in the Gould Research Laboratory and performance tests in the field.*

LET THIS PLAN GO TO WORK FOR YOU...WRITE US TODAY!

Any or all of the material available under the Gould PLUS-PERFORMANCE PLAN is FREE to battery users without obligation. A request on your letterhead stating the particular problem or problems in which you are interested, will bring the appropriate literature—and booklet explaining the complete plan—by return mail. Write us, attention Field Engineering Department.

GOULD

STORAGE BATTERIES

GOULD-NATIONAL BATTERIES, INC., TRENTON 7, NEW JERSEY

Always Use Gould-National Automobile and Truck Batteries

A FOOTE BROS. DRIVE

FOR ANY POWER TRANSMISSION NEED

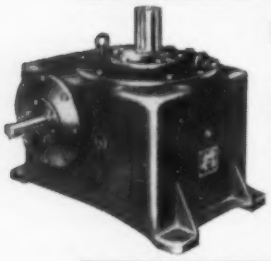
Any requirement for power transmission equipment can be met from Foote Bros. complete line of enclosed gear drives.

Nearly a century of engineering and manufacturing experience is back of these drives. Three large plants contain the newest in gear cutting equipment. New techniques in manufacture—better control of materials—improved manufacturing methods—all assure superior enclosed gear drives. Mail the coupon below for bulletins in which you are interested.

LINE-O-POWER

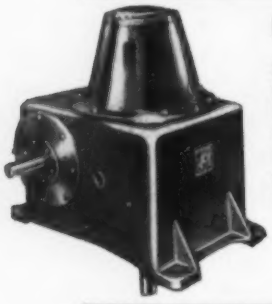
Economical in original cost and operation, these drives incorporate Duti-Rated Gears which have file-hard tooth services and ductile cores, assuring long life. Compact in design. Available in double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower. Write for Bulletin LPB.

VERTICAL DRIVES



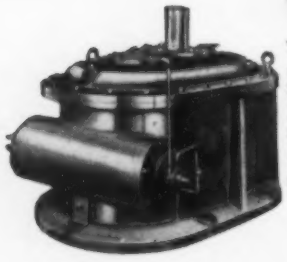
HYGRADE

A quality line of heavy-duty drives, incorporating precision worm gearing that assures high efficiency and load-carrying capacity. Vertical output shaft may extend upward, downward or both. Ratios from 4⅛ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



HYTOP

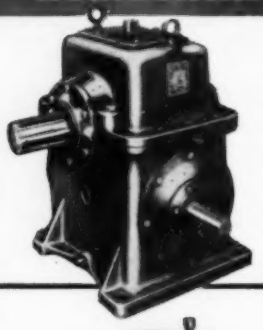
Similar in design to the Hygrade Vertical Drives, but with wider, low-speed bearing span to accommodate long, unsupported vertical output shaft extensions. Vertical output shaft may extend upward, downward or both. Write for Bulletin HGA.



WORM-HELICAL

These drives are admirably suited to applications which require horizontal input and vertical output shafts for heavy-duty service. Available in ratios from approximately 30 to 250 to 1 and a capacity range up to 120 horsepower. Write for information.

HORIZONTAL DRIVES



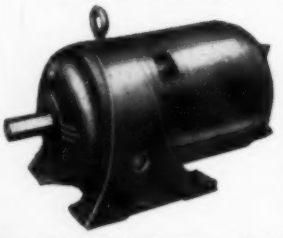
HYGRADE

High quality, heavy duty, enclosed worm gearing that assures high efficiency and load-carrying capacity. Available in a wide range of types to meet any need. Ratios from 4⅛ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.

MAXI-POWER

Heavy-duty helical gear drives. Available in single reduction units, ratios up to 9.91 to 1; capacities up to 1,550 horsepower; double-reduction units, ratios from 9.32 up to 71 to 1, capacities to 1100 horsepower; triple reduction units, ratios from 79 up to 360 to 1, capacities up to 420 horsepower. Write for Bulletin MPB.

FOOTE BROS.-LOUIS ALLIS *Gearmotors*



A compact line of gearmotors in 17 sizes in single, double and triple reductions, incorporating Duti-Rated Gears that assure long wear life and maximum load-carrying capacity. Units use Louis Allis high quality motors—available in a wide range of enclosures to meet any condition. Write for Bulletin GMA.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 South Western Boulevard, Chicago 9, Illinois

Please send me the bulletins checked below:

- ☐ Bulletin HGA { Horizontal Hygrade / Vertical Hygrade / Vertical Hytop
- ☐ Bulletin LPB Line-O-Power
- ☐ Bulletin MPB Maxi-Power
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors

Name.....*Position*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

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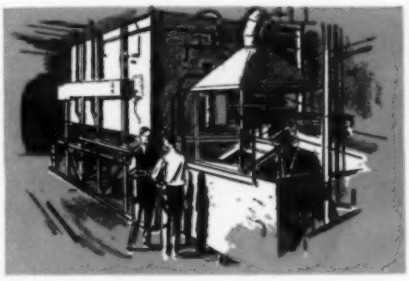

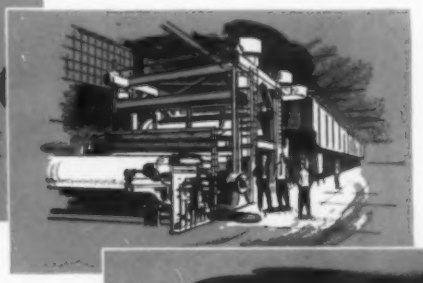

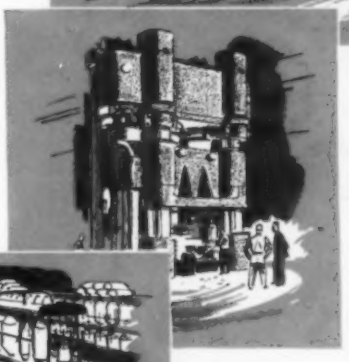

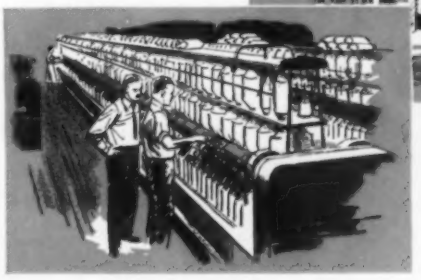

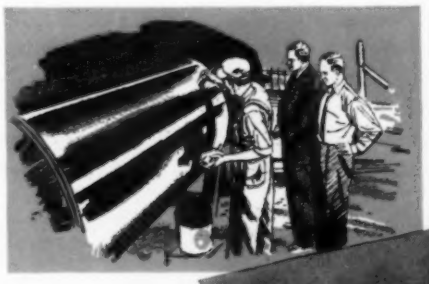

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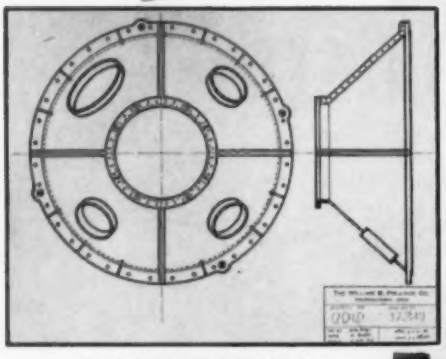
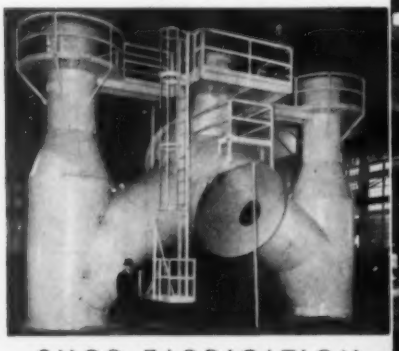
POLLOCK

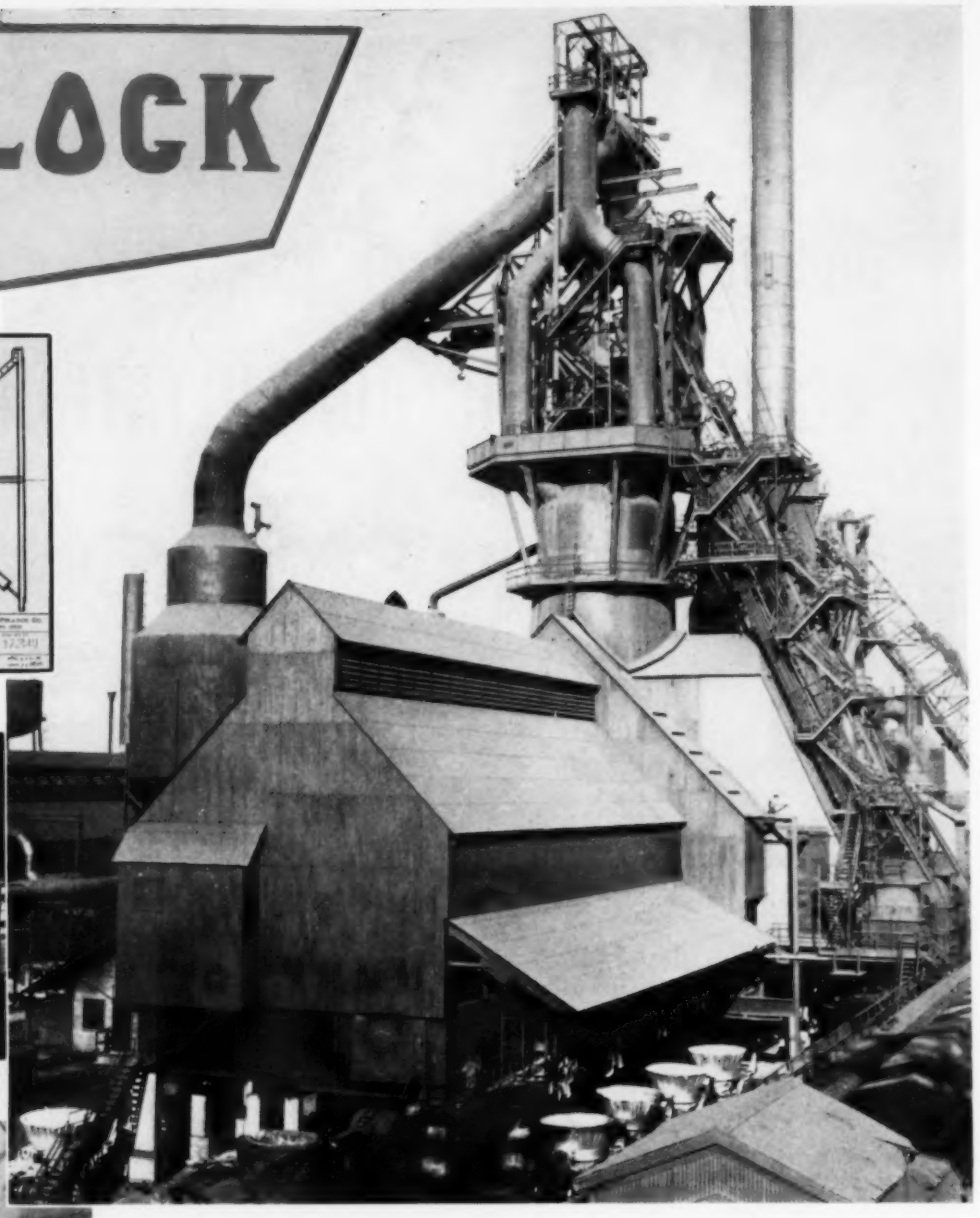


ENGINEERING



SHOP FABRICATION

FIELD ERECTION



Correlating the skills of Pollock engineering, fabrication and field erection to specific operational requirements of The Youngstown Sheet & Tube Company are evidenced in this blast furnace. In addition to furnishing the steel work for this blast furnace, Pollock designed and built auxiliary equipment, including the hot metal ladle cars and cinder cars shown in the above picture. The experience which the Pollock Company has gathered in over eighty-five years is available to you in planning your new projects.

Blast furnace STEEL WORK

POLLOCK

THE WILLIAM B. POLLOCK COMPANY

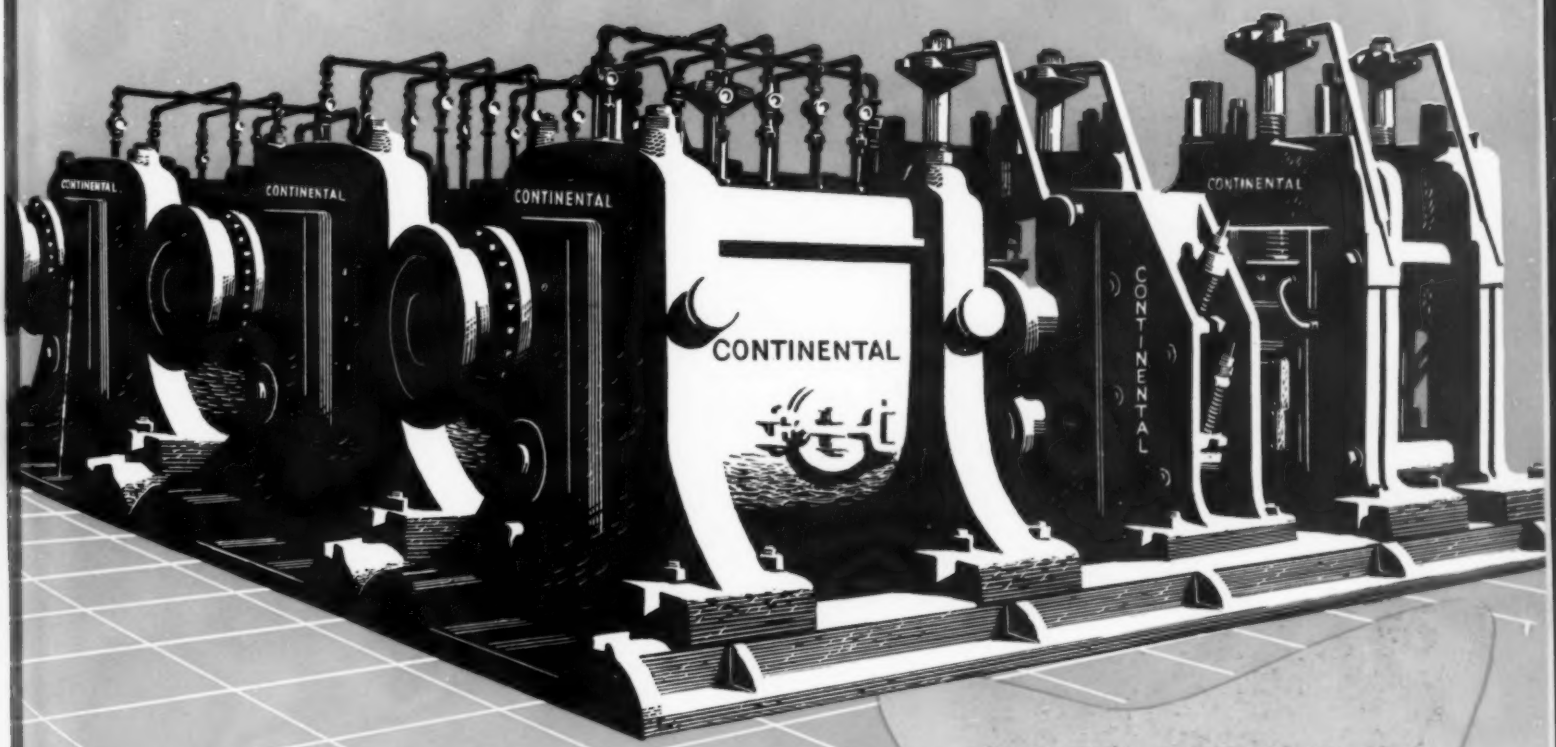
YOUNGSTOWN · OHIO

STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

Continental

BILLET and BAR MILLS



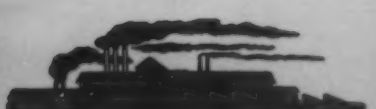
Designed and built by Continental with full complement of auxiliary mill equipment.

Continental

FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

Plants at: E. Chicago, Ind.; Wheeling, W. Va.; Pittsburgh, Pa.



ROLLS: Iron, Alloy Iron and Steel; for all types of rolling mills.

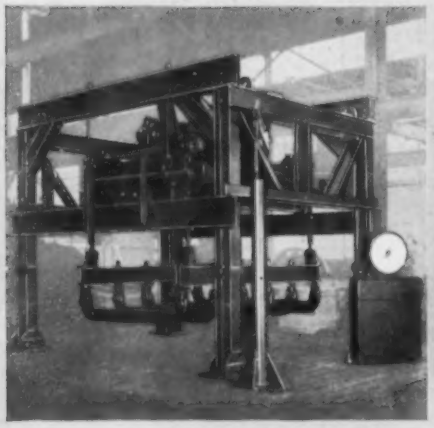
CASTINGS: Carbon and Alloy Steel, ranging from 20 to 250,000 lbs.

ROLLING MILLS: Designers and producers of complete mill installations and auxiliary equipment.

Continental Plate Scale and Piler. Insert below, closeup of Plate Scale Table.

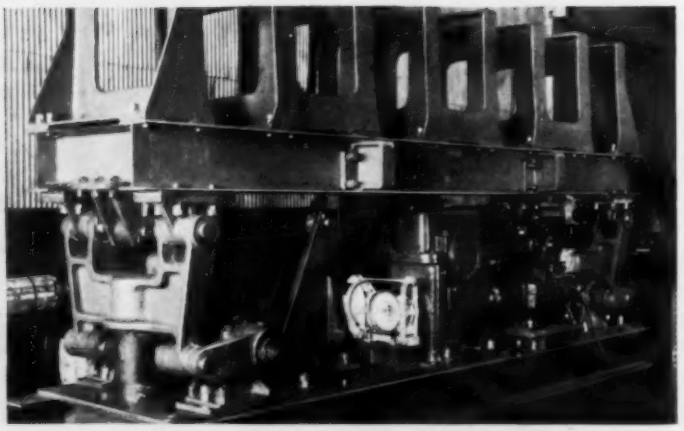
Continental

WEIGHING EQUIPMENT



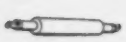
Overhead Slab Scale

Ingot Turner and Scale



Elevating Platform Bloom Scale

Continental
FOUNDRY & MACHINE CO.
CHICAGO • PITTSBURGH
Plants at: East Chicago, Ind., Wheeling, W. Va., Pittsburgh, Pa.



ROLLS Iron, Alloy Iron and Steel; for all types of rolling mills.

CASTINGS Carbon and Alloy Steel, ranging from 20 to 250,000 lbs.

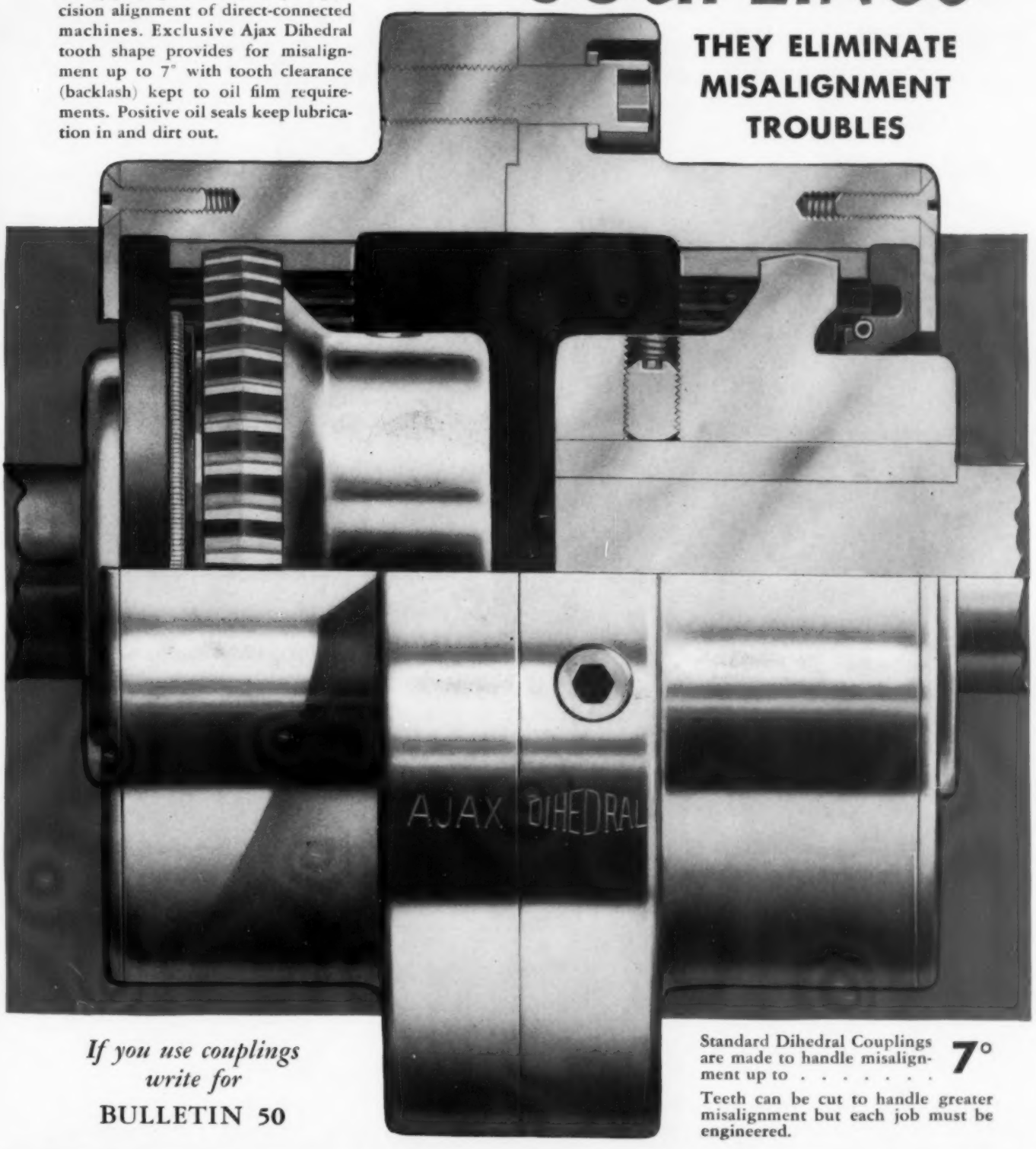
ROLLING MILLS Designers and producers of complete mill installations and auxiliary equipment.

Announcing AJAX DIHEDRAL COUPLINGS

*

Design, installation and maintenance men can now save thousands of dollars by getting rid of necessity for precision alignment of direct-connected machines. Exclusive Ajax Dihedral tooth shape provides for misalignment up to 7° with tooth clearance (backlash) kept to oil film requirements. Positive oil seals keep lubrication in and dirt out.

THEY ELIMINATE MISALIGNMENT TROUBLES



If you use couplings write for

BULLETIN 50

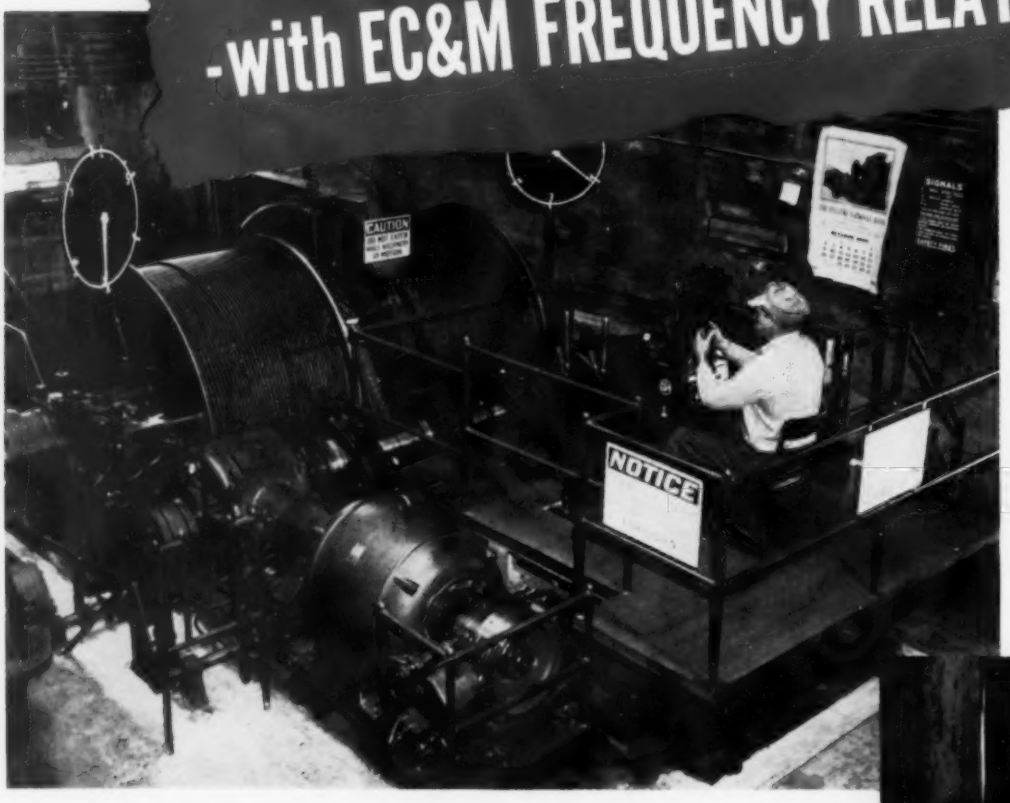
Standard Dihedral Couplings are made to handle misalignment up to . . . . . **7°**

Teeth can be cut to handle greater misalignment but each job must be engineered.

AJAX FLEXIBLE COUPLING CO. INC. Westfield, New York

A wide choice of cage speeds on this Two-Motor Mine-Hoist

-with EC&M FREQUENCY RELAY CONTROL



The EC&M Type WB Brake shown on the end of the motor shaft is quick-setting and fast-releasing — maintains high efficiency of the hoist.

● The passengers get a velvet-smooth ride on this mine-hoist. Although the weight of a stone load or passenger load in the cage varies over wide limits, this EC&M Frequency Relay Controller permits adjusting the torque of the two 75 HP, 440 volt wound rotor induction motors to cause the cage to creep, to run at full speed or to operate at intermediate reduced speeds.

Speed-selection is under the operator's cam-type, multi-speed-point, Master Switch. EC&M Frequency Relays automatically switch motor connections to maintain safe operation under all conditions. No. 28 ACCELERATOR Bulletin describes this mine-hoist installation—write for your copy.

Cage creeps to a stop with passengers.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Straight story about TIMKEN® bearings

THE new Taylor Wilson rotary straightener shown below can handle heavy wall alloy tubing up to 9⅝" diameter. Tubing is straightened by a total of eight rolls—four driven rolls, one entry roll, two idling rolls and one delivery roll. All are mounted on Timken® tapered roller bearings for friction-free trouble-free operation.

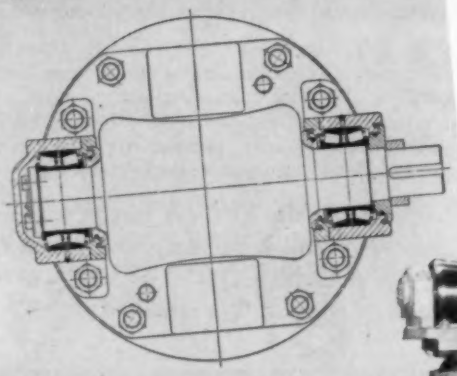
Timken bearings are also used in the main drive and the auxiliary drive. Due to the line contact between the rollers and races, Timken tapered roller bearings have extra load-carrying capacity. Their tapered construction permits them to take radial as well as thrust loads in any combination. Deflection and end-movement are minimized, wear on moving parts reduced.

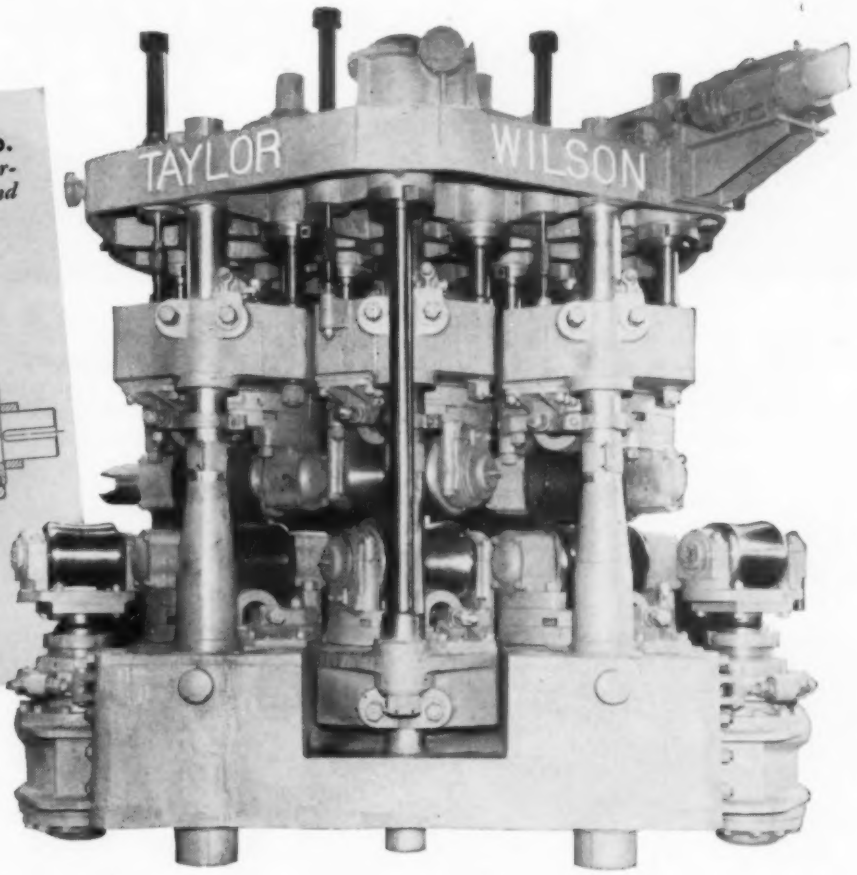
Timken bearings are manufactured to extreme limits of precision and finished to incredible smoothness, resulting in practically friction-free operation. Under normal usage they last the life of the machine because they are (1) engineered for the job, (2) made of Timken fine alloy steel and (3) precision manufactured.

The dependable performance of Timken bearings has made products equipped with Timken bearings first choice throughout industry. When you specify bearings, specify Timken bearings. And when you buy new equipment, make sure it has the advantages that only Timken bearings can give it. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

How **TAYLOR WILSON MANUFACTURING CO.** *mounts straightener rolls on Timken bearings for dependable, low-cost service and long life.*





IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←

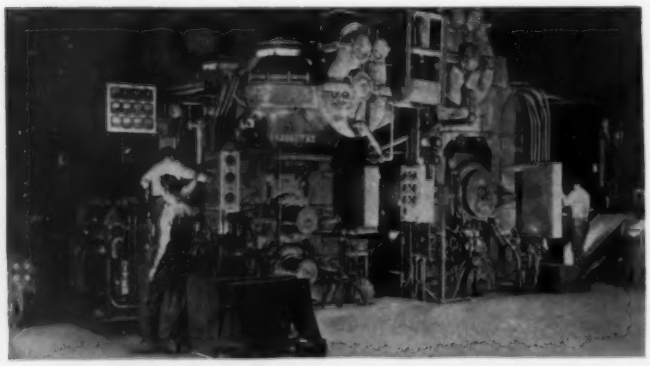
G-E drive holds accurate tension on world's fastest temper mill!

Teams up G-E amplidyne regulators with sensitive G-E regulating tensiometer to maintain uniformity and quality of steel strip—at 5000 fpm!

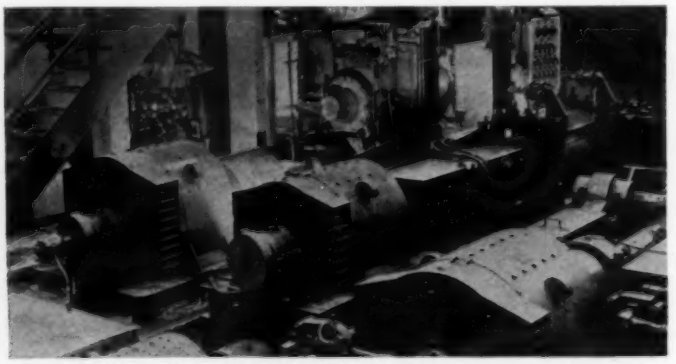
Almost a mile a minute! That's the record speed of this new two-stand temper pass cold strip mill, electrically engineered and equipped throughout as a unit by General Electric. Designed for greater steel output, this fastest mill of its kind benefits from such important features as these:

• **Full-range amplidyne tension regulators between stands and pullers, and pullers and reels, automatically compensate for all roll-diameter combinations, eliminating operator adjustments, simplifying operation.** • **Fast-acting, sensitive regulating tensiometer automatically maintains accurate tension between stands regardless of rolling-load distribution, helps assure uniform steel quality.** • **Individual-motor drive allows low-maintenance mechanical simplicity, reduces drive inertia for faster acceleration and deceleration, increased production.**

Here is further proof that G-E can handle successfully *any* steel-mill drive problem—including *yours*. Ask the G-E steel-mill specialist in your area to talk it over with your engineers. *General Electric Company, Schenectady 5, N. Y.*



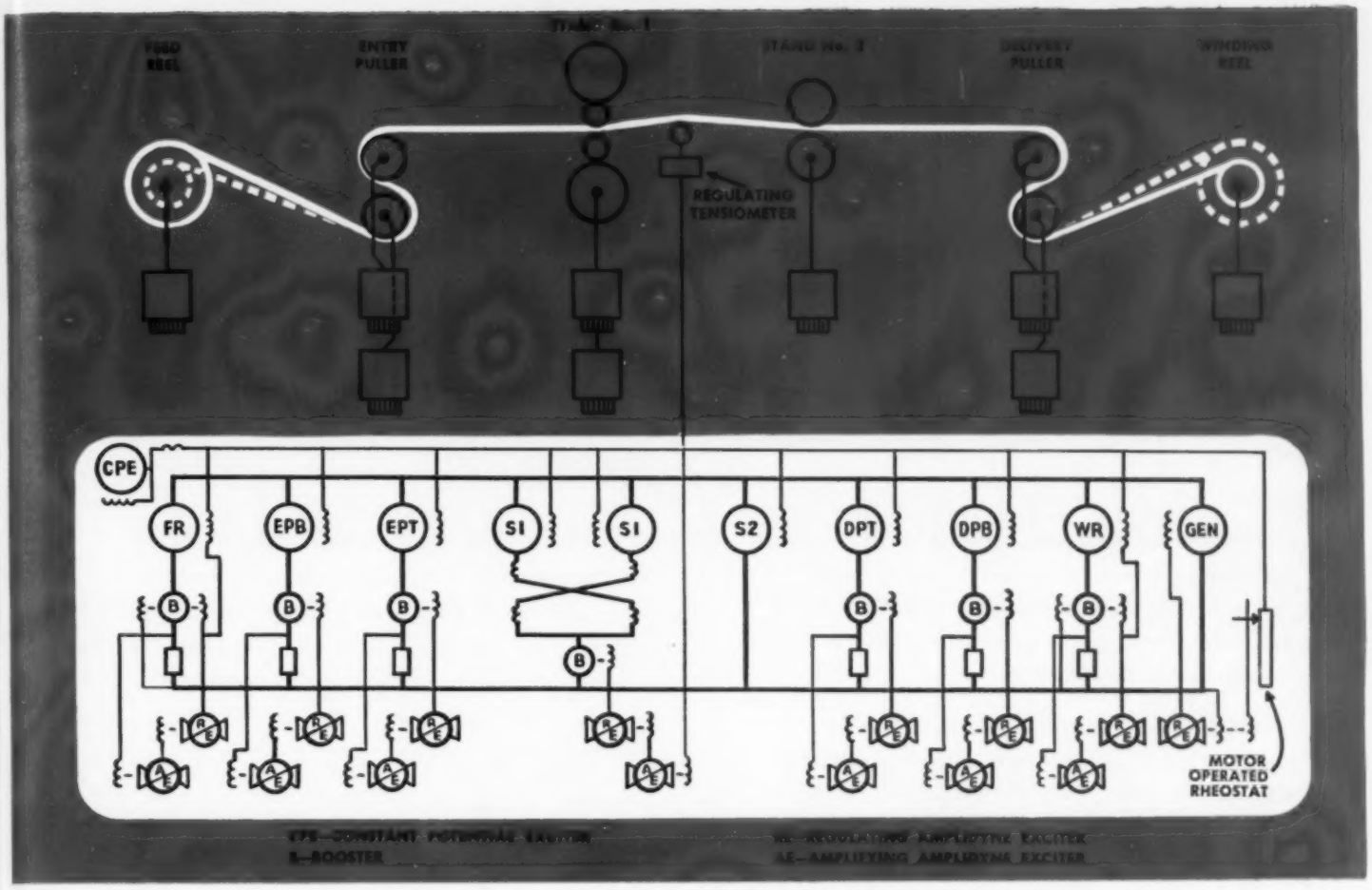
All electric equipment for this 5000-fpm temper mill—switchgear, motor-generator sets, drive and auxiliary motors, control, and ventilation apparatus—was engineered and supplied by General Electric, with G-E steel-mill specialists also helping on installation and tune-up.



Rear view shows four of the mill's 9 G-E 600-volt d-c drive motors (left to right): Stand No. 2 600-hp motor, two twin-drive 400-hp delivery puller motors, and 400-hp winding-reel motor. Extra-tough, these G-E motors, designed for metal-rolling service, are built to last in extra-tough steel-mill duty.

GENERAL ELECTRIC

659-81

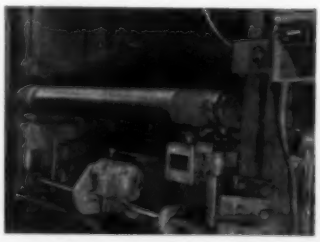


HOW THIS G-E DRIVE WORKS:

All motors are connected to a common bus supplied by a single generator. The entire mill is accelerated and decelerated by armature voltage control of the main generator, provided by a motor-operated rheostat and an amplidyne voltage regulator. Stand No. 2 motor operates directly from bus voltage and with constant field strength, so that it acts as pace-setter for all of the mill's main drive motors.

Tension reels and pullers are provided with sensitive, compensated, amplidyne current regulators which maintain accurate tension at all speeds. Tension between stands, measured by a tensiometer, is compared with a reference standard set by the operator. Any difference between the two is translated by the amplidynes into a booster voltage which acts on the Stand No. 1 motor to produce the desired value of tension.

G-E regulating tensiometer helps speed up operations



An important factor in controlling the temper and flatness of the strip rolled in this mill, and in preventing strip breakage between stands, is the G-E regulating tensiometer, similar to the one shown. With a sensitivity that reacts to only 0.1 inch vertical displacement of the roll from low to high tension, it assures the fast, accurate response required—even at speeds greater than 5000 fpm. Moreover, tension is regulated continuously and to a closer degree than is possible by depending upon human judgment.

another example of
GENERAL ELECTRIC
drive engineering at work!

Here is where L&N instruments can help steel makers...

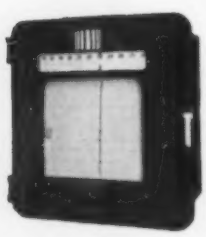
PRODUCERS of iron and steel who are out to make more tonnage and meet closer specs—in spite of material and manpower shortages—will find the instruments and applications shown here exactly tailored to their needs.

Here's why! (1) Hundreds of practical mill men—fuel engineers, first helpers, metallurgists, melters, instrument foremen, superintendents, quality control technicians of all sorts—helped us design these equipments. Our contacts in U.S. Steel, in J&L, Bethlehem, National, Armco, Crucible, Inland, Alan Wood, Granite City, Youngstown, Lukens, Republic and many others have for years used our equipment. Operating qualities, flexibility features and rugged construction are as these men have specified during the 40 years since Midvale bought the steel industry's very first potentiometer pyrometer from us. Yes, L&N instruments are not simply "adapted" to steel mill problems—*they're designed to meet and solve them.*

(2) You can choose from the most complete array of instruments ever available to the steel industry. For each measuring and control problem in the processes shown at right, you'll find an L&N instrument with the qualities needed *for that particular job.* Some are shown below; many are omitted for lack of space.

(3) You get outstanding performance because L&N instruments are *applied* correctly. Into each installation goes the know-how accumulated by men who have spent their entire careers in working with and in the steel industry.

The coupon on the opposite page will bring details of any instrument or application. Because the steel industry is moving so rapidly—is so alert technically—make certain you get the latest specific instrumentation data quickly by identifying the process in which you're interested.



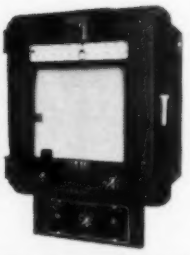
STRIP CHART SPEEDOMAX OR MICROMAX

ROUND CHART MICROMAX

ROUND CHART SPEEDOMAX

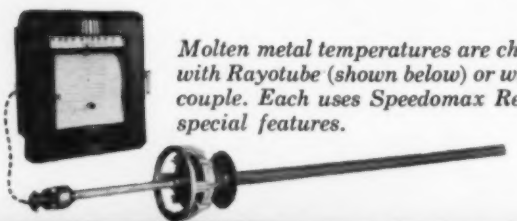
SPEEDOMAX INDICATOR

ELECTROMAX CONTROLLER

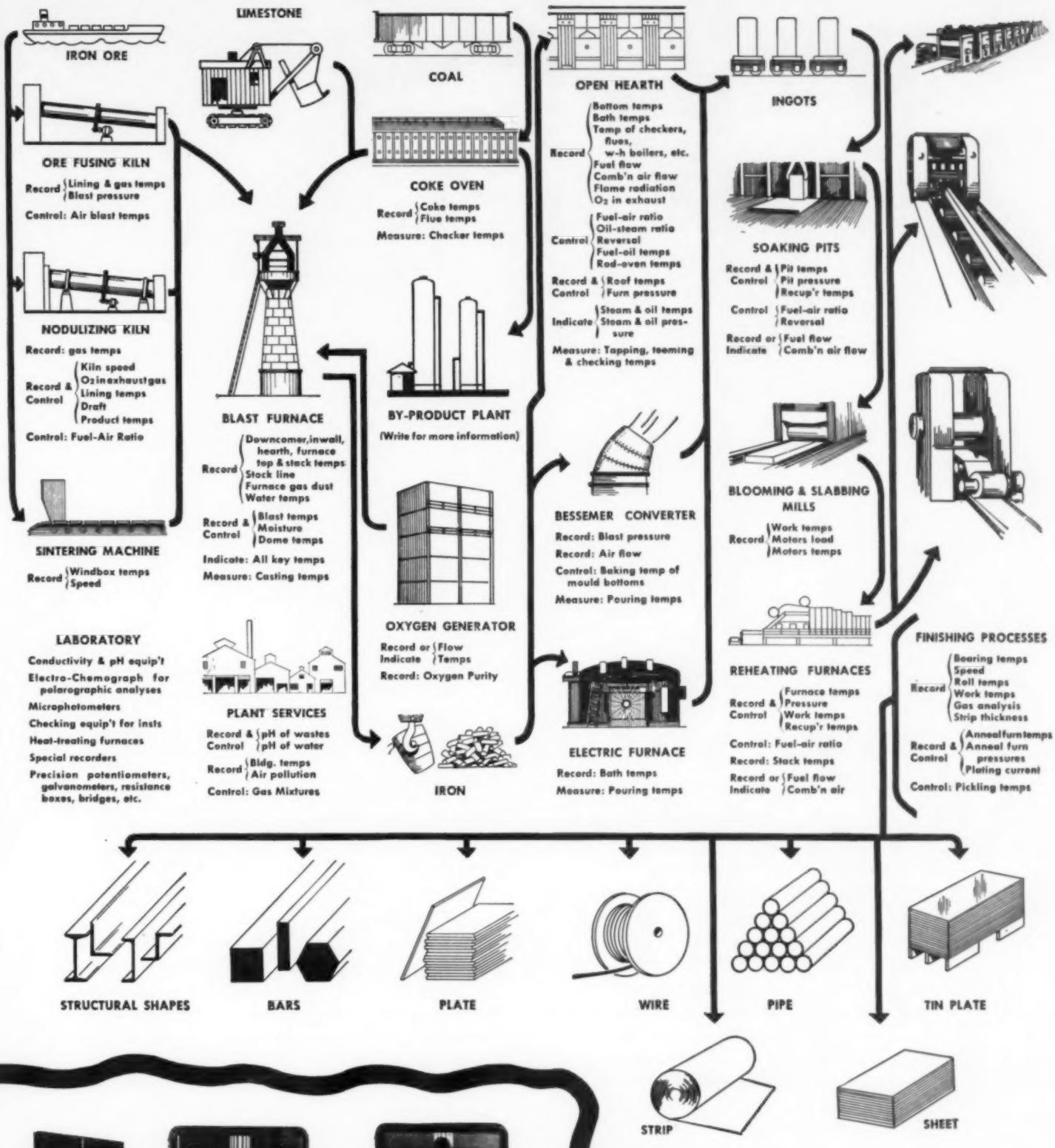


SPEEDOMAX PNEUMATIC CONTROLLER

These instruments measure temperature, speed, pH, electric load, flow and most other conditions except combustion and draft (for which see right). Micromax is galvanometer type; Speedomax is electronic. Strip chart instruments can record up to 16 points in up to 6 colors; round chart models are 1- or 2-point. As controllers, either electric or pneumatic systems may be used. Hundreds of standard ranges are available ... hundreds of special features for special needs.



Molten metal temperatures are checked either with Rayotube (shown below) or with Thermocouple. Each uses Speedomax Recorder with special features.


IRON ORE
LIMESTONE
COAL
ORE FUSING KILN
Record { Lining & gas temps / Blast pressure
Control: Air blast temps
COKE OVEN
Record { Coke temps / Flue temps
Measure: Checker temps
OPEN HEARTH
Record { Bottom temps, Bath temps, Temp of checkers, flues, w-h boilers, etc., Fuel flow, Comb'n air flow, Flame radiation, O2 in exhaust
Control { Fuel-air ratio, Oil-steam ratio, Reversal, Fuel-oil temps, Rod-oven temps
Record & Control { Roof temps / Furn pressure
Indicate { Steam & oil temps / Steam & oil pressure
Measure: Tapping, teeming & checking temps
INGOTS
SOAKING PITS
Record & Control { Pit temps, Pit pressure, Recup'r temps
Control { Fuel-air ratio / Reversal
Record or Indicate { Fuel flow / Comb'n air flow
NODULIZING KILN
Record: gas temps
Record & Control { Kiln speed, O2 in exhaust gas, Lining temps, Draft, Product temps
Control: Fuel-Air Ratio
BLAST FURNACE
Record { Downcomer, inwall, hearth, furnace top & stack temps, Stock line, Furnace gas dust, Water temps
Record & Control { Blast temps, Moisture, Dome temps
Indicate: All key temps
Measure: Casting temps
BY-PRODUCT PLANT
(Write for more information)
BESSEMER CONVERTER
Record: Blast pressure
Record: Air flow
Control: Baking temp of mould bottoms
Measure: Pouring temps
BLOOMING & SLABBING MILLS
Record { Work temps, Motors load, Motors temps
SINTERING MACHINE
Record { Windbox temps / Speed
OXYGEN GENERATOR
Record or Indicate { Flow / Temps
Record: Oxygen Purity
LABORATORY
Conductivity & pH equip't
Electro-Chemograph for polarographic analyses
Microphotometers
Checking equip't for insts
Heat-treating furnaces
Special recorders
Precision potentiometers, galvanometers, resistance boxes, bridges, etc.
PLANT SERVICES
Record & Control { pH of wastes / pH of water
Record { Bldg. temps / Air pollution
Control: Gas Mixtures
IRON
ELECTRIC FURNACE
Record: Bath temps
Measure: Pouring temps
REHEATING FURNACES
Record & Control { Furnace temps, Pressure, Work temps, Recup'r temps
Control: Fuel-air ratio
Record: Stack temps
Record or Indicate { Fuel flow / Comb'n air
FINISHING PROCESSES
Record { Bearing temps, Speed, Roll temps, Work temps, Gas analysis, Strip thickness
Record & Control { Anneal furn temps, Anneal furn pressures, Plating current
Control: Pickling temps
STRUCTURAL SHAPES
BARS
PLATE
WIRE
PIPE
TIN PLATE
STRIP
SHEET

P.A.T. 50
CONTROL PANEL

AIR-FUEL RATIO
CONTROLLER

FURNACE PRESSURE
CONTROLLER

Integrated Control Panels provide these and related instruments to hold combustion, draft & temperature at specified points; panels arrive at mill completely assembled & tested.

P.A.T. 50 Control is the only proportional electric control with fully-adjustable rate action as well as reset; for fast-acting, non-overshooting regulation of either long-lag or short-lag processes, whether or not subject to load fluctuations. For all controllable conditions.

LEEDS & NORTHRUP CO.
4942 Stenton Ave., Phila. 44, Pa.

Please send / bring information about instruments for the following: .....

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(Name) (Title)

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(Firm)

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Jrl. Ad N-0661(2)

Found:

ONE GEAR THAT LASTS AS LONG AS THREE

Another case that shows how National Bearing Division has reduced operating costs

When any machine makes a habit of breaking down periodically, it's time to take stock of the problem—before production losses and replacement costs skyrocket. That's just what faced a large Midwest steel plant . . . frequent breakdowns of a takeup frame used in coiling wire. The wire, under tension, built up stresses that caused the transmission gears to strip.

National Bearing Division engineers made a special study of this mill's problem. They recommended changing to a bronze alloy known for its ability to retain the anti-frictional qualities of bronze, yet have an unusually high degree of strength.

Result? Not a single gear supplied by National Bearing Division in this alloy has stripped in the last three years! That compares with the former average service of just six months.

Any production man will know that the savings are tremendous, especially over a period of years . . . savings made possible by National Bearing Division metallurgical research on bronze application—*plus the engineering skill to interpret this research in terms of solving an on-the-job problem.*

It's another example showing that we have the facilities, the experience and the *proved* ability to save money for our customers on any problem involving . . .

Non-Ferrous Bearings and Castings—
As-Cast or Machined

Bronze Bars—
As-Cast or Machined;
Cored, Solid, Hexagon

Babbitt Metals—
For every type of bearing service

NBM

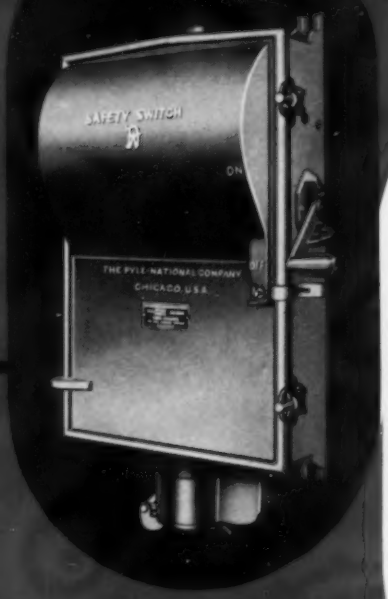
AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION
4936 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Heavy Duty Safety Switch, and Circuit Breaker

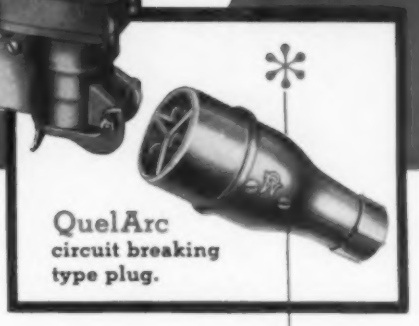
RAIN-TIGHT! DUST-TIGHT!



RAIN-TIGHT SAFETY SWITCHES with receptacle, fusible or fuseless, ratings up to 100 amps, 600 volts . . . without receptacle, up to 200 amps, 600 volts. (NEMA TYPES V, IV and III)

DUST-TIGHT AND RAIN-TIGHT CIRCUIT BREAKERS with receptacle, ratings up to 100 amps, 600 volts . . . without receptacle, up to 225 amps, 600 volts. Dust-tight types for hazardous locations, Class II, group E, F, and G. (NEMA TYPES IX, V, IV and III)

PYLETS



QuelArc circuit breaking type plug.

Designed for Safe, Reliable Operation and Protection of Portable and Stationary Electrical Equipment, indoors and outdoors, under the most severe operating conditions

MUCH LONGER SERVICE LIFE AND LOWER MAINTENANCE COSTS insured by heavy, rust-resisting cast metal construction and rain-tight gasket seals.

COMPLETE SAFETY FOR THE OPERATOR is provided by safety circuit grounding and the interlocking of door and plug receptacle with a quick make and break switch mechanism.

Consult your Pylet Catalog, Bulletin 1150 for complete listings.

PYLE QuelArc plugs, used with this equipment, are well known industrially, for their unique partitioned construction. Long insulating surfaces from pole to pole, and from poles to ground provide for exceptionally safe handling and long service life.

SINCE 1897

THE PYLE-NATIONAL COMPANY
1383 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

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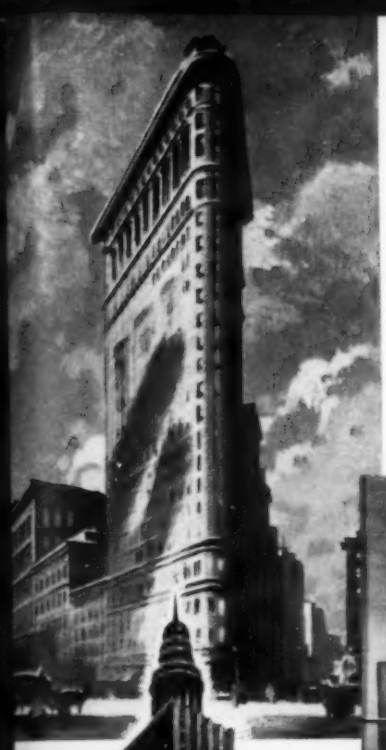
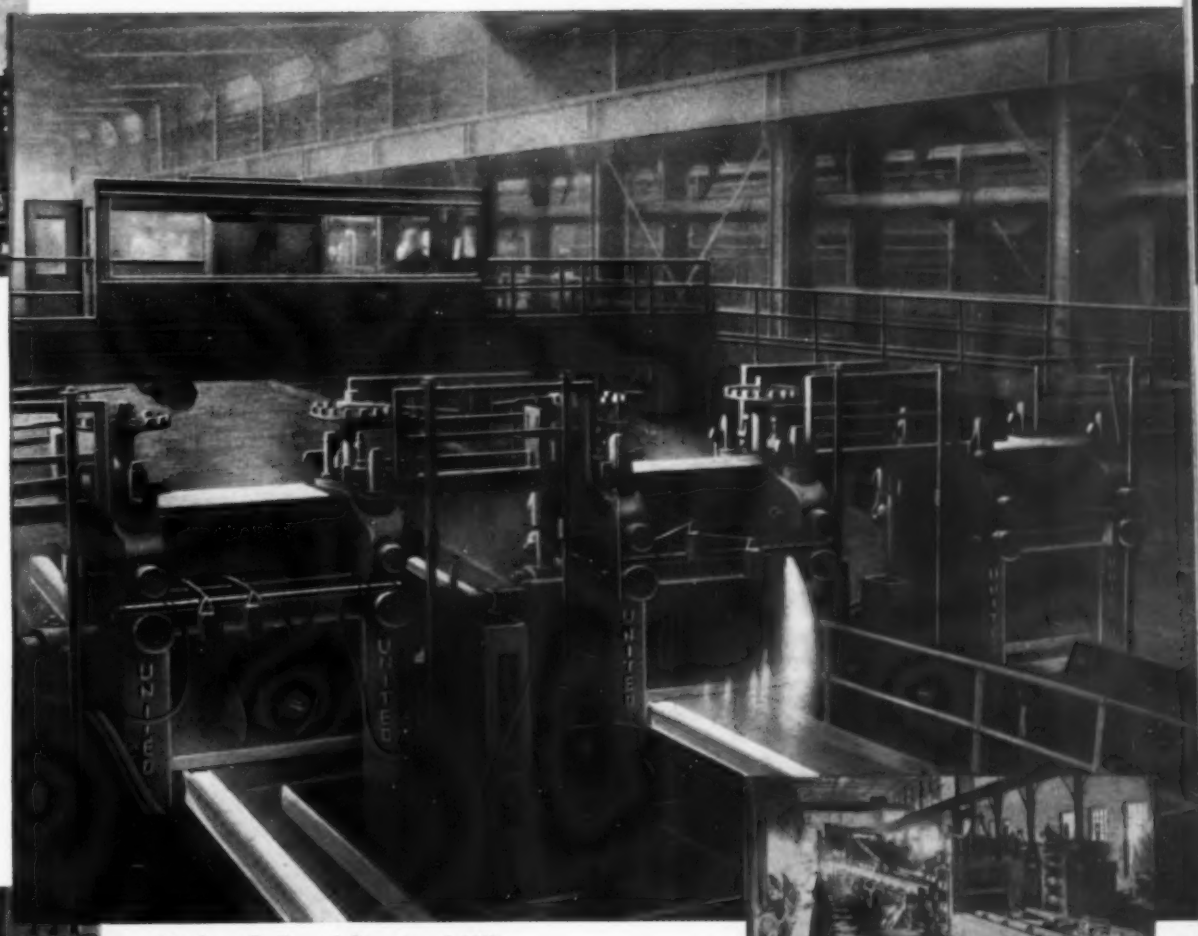
PLUGS AND RECEPTACLES • FLOODLIGHTS • TURBO-GENERATORS • GYRALITES • CONDUIT FITTINGS • MULTI-VENT AIR DISTRIBUTION

Giant
with
facile jaws
When the sturdy Brosius Auto Floor Forging Manipulator takes a billet or blank in its teeth, it improves upon every action possible with chain hoist and porter bar or cumbersome overhead equipment. More swiftly and easily it draws or charges . . . moves more quickly and independently across the forging floor . . . manipulates at hammer or press with more sensitive movements. Moreover, this remarkable modern mammoth brings to your forge shop added production, added safety, added economy — you should be using one. Write us.
It tilts up and down—
raises and lowers—
rotates—and moves
from side to side
BROSIUS DIVISION
Salem-Brosius, Inc., Pittsburgh 15, Pa.
Affiliates: Salem Engineering Division,
Salem Engineering Co., Ltd., Milford nr. Derby, England; Salem Engineering (Canada) Ltd., Toronto, Canada

50 YEARS AGO

A Skyscraper Was Something to Wonder At





Modern Rail and Structural Mill

Early Rail and Structural Mill

ELEVATORS did not climb so high nor go up so fast, a half century ago. Steel framing did not lift the pinnacles of architecture so far aloft. The rolling mill had not, under prompting of the designer and engineer, specialized its output of structural members on which to hang such curtains of stone or steel or aluminum as enclose the towers now rising above our cities. As yet there was no need. Skyscrapers as they were known even then were wonderful. Imagination had dared nothing more.

Requisition and performance have followed one upon the other. Now it is said that height is limited only by desire.

UNITED is proud of its contribution to the progress of modern rolling which has given such freedom to building construction.

UNITED engineers will welcome opportunity to study and make recommendations on any problem of enlarged or improved production of structural material.

Golden Anniversary 1901 UEFCO 1951

UNITED

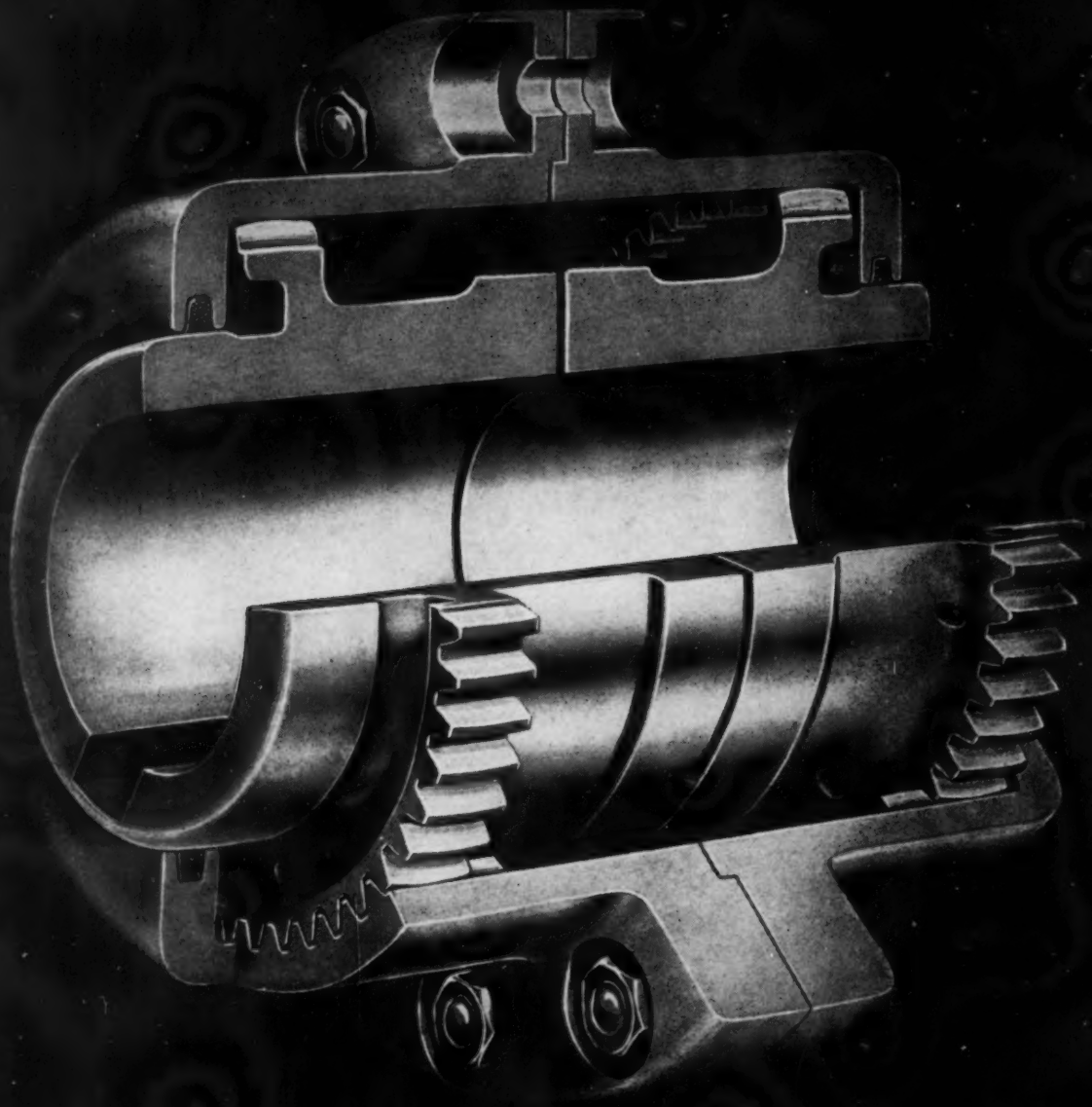
ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO • LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE • STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

6 point Temperature Recorder

with single-point vigilance

THE MULTI-RECORD DYNALOG*

By recording up-to-6 points in rapid succession, the Foxboro Multi-Record Dynalog gives the immediate warning of temperature drifts that you'd expect only from single-point recorders . . . all 6 records appear like unbroken lines! Check these outstanding features:

- **High speed recording—6 seconds between prints for maximum continuity of records**
- **Each record in a distinctive, non-smudging color**
- **Unique electronic circuit requires no standardizing, battery, galvanometer, or slide wire . . . gives STEPLESS continuous balancing**
- **Unmatched accuracy, lowest maintenance, greatest convenience**
- **Thermocouple and resistance-bulb types**
- **Uses convenient, low cost circular charts**

Get the *full* story. Write for Bulletin 427-1. **The Foxboro Company, 585 Neponset Avenue, Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

Another **FOXBORO** *FIRST*

Reg. U. S. Pat. Off.

...Another new battery of Koppers-

Becker Coke Ovens for Inland Steel

● Recently completed for Inland Steel Company's Indiana Harbor Works, this new battery of 65 Koppers-Becker Coke Ovens is operating at capacity; it is carbonizing approximately 1,400 net tons of coal per day at a coking rate of 1.08 inches per hour.

In this battery, the low-differential Koppers-Becker Underjet Coke Ovens are underfired with coke-oven gas. Provision has been made for future underfiring with blast-furnace gas.

Each of these coke ovens is 40 feet, 1 inch long, 12 feet high and 18¼ inches in average width, with a 3-inch taper. The oven walls incorporate Koppers patented Hammerhead Construction.

In addition to designing and constructing this new coke-oven plant, Koppers engineers altered and extended the steel plant's coal-handling system. The installation included a new quenching station.

Constructing coke ovens and related equipment is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

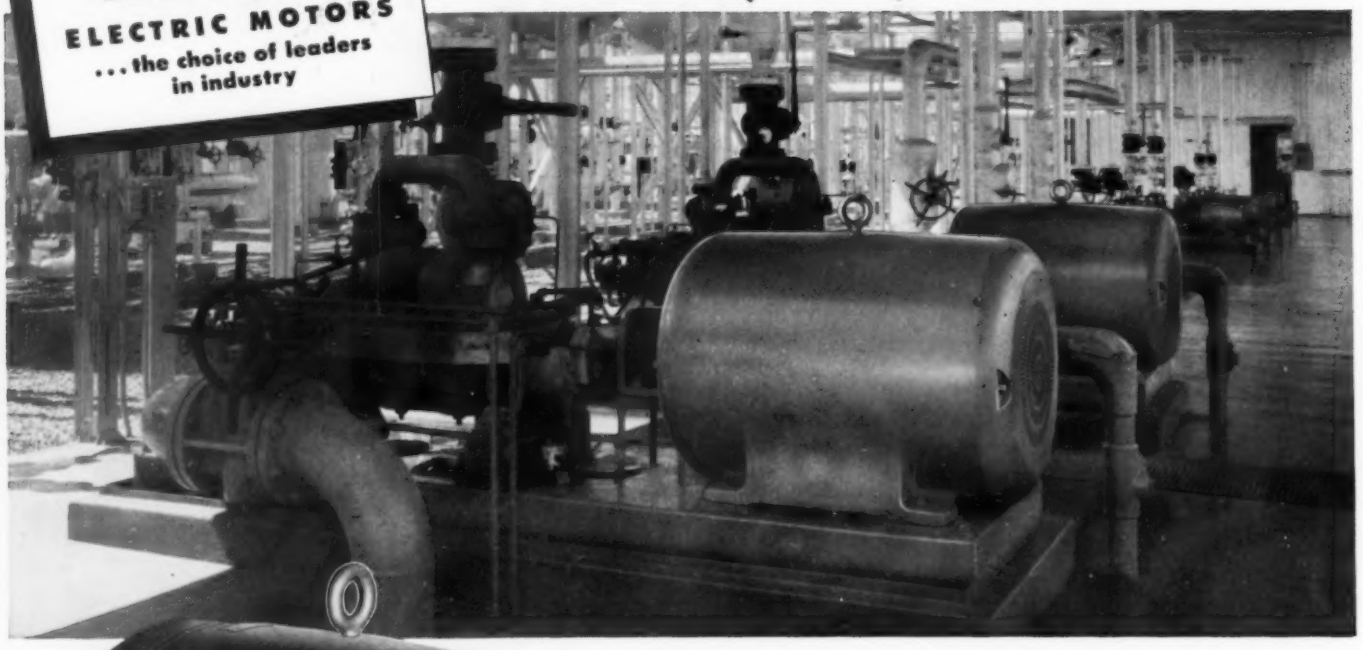
KOPPERS

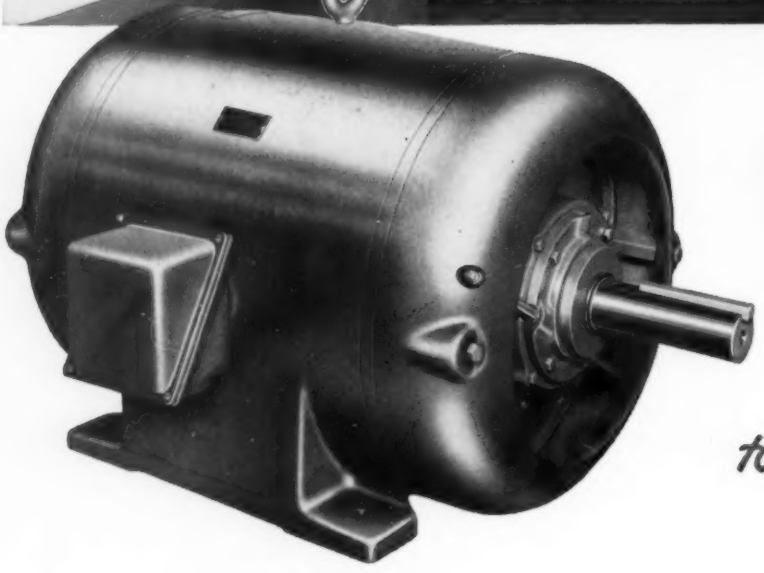
Engineering and Construction Division

KOPPERS COMPANY, INC. • PITTSBURGH 19, PA.

Wagner
ELECTRIC MOTORS
... the choice of leaders in industry

Built for your protection...





Wagner

Cast-Iron Frame MOTORS

totally enclosed...fan cooled ...corrosion-resistant

These totally-enclosed fan-cooled motors are built to take it—destructive elements, dirt or dust, acids or fumes don't interfere with their dependable operation.

Wagner cast-iron motors are especially suitable for installation in steel mills, mines, chemical plants, refineries and for other applications where corrosion is a problem, because practically all exposed parts are made of heavy, corrosion-resistant cast iron.

Where protection against explosive atmospheres is required, an explosion-proof design (type JP) can be furnished. Both the standard totally-enclosed type and the explosion-proof type are available in ratings from 2 to 250 horsepower, with either normal torque or high torque characteristics.

Wagner's new Bulletin MU-132 gives complete information on these fully-protected motors. Write for your copy today. Thirty-one branch offices, located in principal cities, are ready to assist you in any motor application problem.

®Wagner Electric Corporation
1891 WE 1951

MB1-10

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

5 BRUSHES FOR MILL-TYPE MOTORS

join NATIONAL Carbon's famous standardized brushes!

In the table below, you will find the latest list of "National" standardized carbon brushes for steel mill applications.

Grade AX-5 was chosen because it has performed more successfully on mill motors than any other grade. Grade 401 has an equally impressive record on older type motors.

You get these brushes at the same low, flat price, whether you buy one box or 10,000 boxes. For convenience, order by NC-number.

STANDARDIZED BRUSHES FOR MILL-TYPE MOTORS

NC Number	A.I.S.E. Std. No.	Specifications	Applications
20-4800	29	2¼ x 1½ x ⅝ AX-5	MC 8-12-21-81-121 MD 104-406-408-412-416-418 W 610 K 4-KG4
20-5600	32	2¼ x 1¾ x ⅝ AX-5	MC 50-608 MD 410 K5-KG5
24-4800	38	2½ x 1½ x ¾ AX-5	MC 12-60-101-121-612-614 MD 418 MT 00-0
24-5600	40	2¼ x 1¾ x ¾ AX-5 "Plytek" (⅜-⅜)	MD 414-612-616
24-6400	42	2½ x 2 x ¾ 401	MC 14-16-18-70-80-90-100 103-141-161-181-610 MD 420-421-422 SW 75-EW-FW-14W75- 18W150-K6-KG6

Order by NC Number

FOR COMPLETE INFORMATION on National Carbon's brush standardization program and the advantages it offers, write to National Carbon Company, A Division of Union Carbide and Carbon Corporation, Dept. IS.

SLASH BATTERY COSTS IN HALF!

With the revolutionary new "Eveready" No. 1050 Flashlight Battery, you get these big exclusive features:

- More than twice as much light
- Whitest, brightest light available from a flashlight battery
- Half the cost for light output
- Leakproof — No metal can to leak or corrode
- Will not swell, stick or jam in a flashlight

Why? Because of "Eveready" No. 1050's exclusive "inside out" construction. Instead of being the container for the cell, the zinc electrode is on the inside to make the battery last longer, while the new outside carbon jacket makes the battery leakproof. *Order a supply of No. 1050's today.*

The terms "National", "Plytek", "Eveready" and the Three Pyramids Device are registered trade-marks of

NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N. Y.

DISTRICT SALES OFFICES: ATLANTA • CHICAGO • DALLAS • KANSAS CITY • NEW YORK • PITTSBURGH • SAN FRANCISCO

Says the Superintendent of a large Process Industries Plant:

"Speaking for our men,
HERE'S WHY WE LIKE
HOMESTEAD
LEVER-SEALD VALVES–

- They Operate Easily
- Give full flow almost instantly
- They're Stick-Proof
- They last 3 to 4 times longer than other valves"

This plant's experience is typical of that of thousands of other users, and tells why Homestead Lever-Seald Valves have been first choice for more than 18 years for services where corrosive fluids, slurries, abrasives, or extremes of temperature or pressure cause ordinary valves to fail.

Homestead Lever-Seald Valves are stick-proof; require less maintenance; and the means for easy turning under all conditions, is built right into the valve. We can furnish them in stainless steel, steel, iron, brass or alloys to meet your needs; sizes 1½" to 10"; for pressures from vacuum to 1500 lbs.

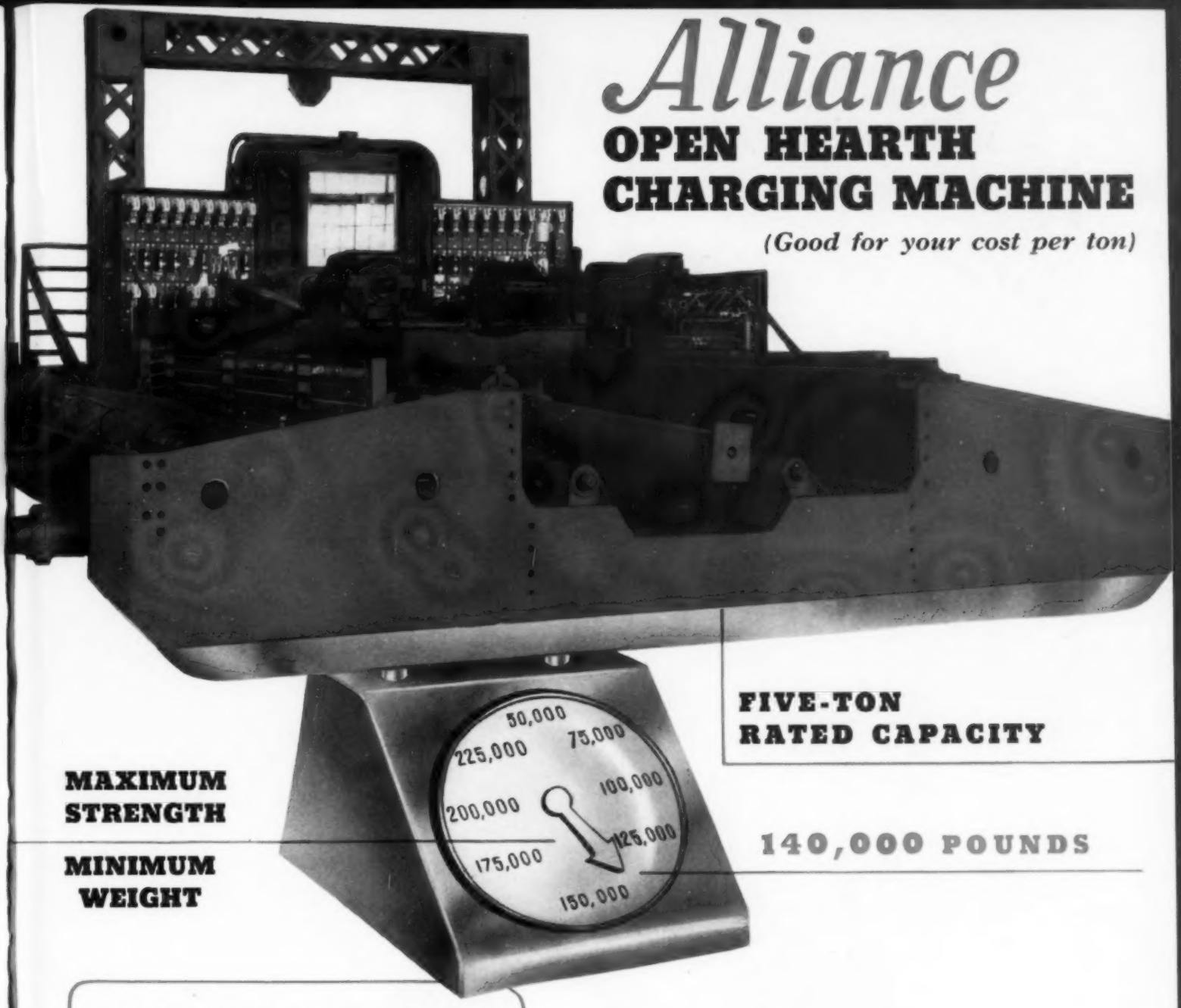
Write for valve reference book
No. 39-3. No obligation.

HOMESTEAD VALVE MANUFACTURING CO.
"Serving Since 1892"

P. O. BOX 21 **CORAOPOLIS, PA.**

Alliance
OPEN HEARTH CHARGING MACHINE

(Good for your cost per ton)



FIVE-TON RATED CAPACITY

MAXIMUM STRENGTH

140,000 POUNDS

MINIMUM WEIGHT

with these exclusive *Alliance* features

- ★ Spring-loaded pitman prevents shock on peel.
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● This new 5-ton capacity open hearth Charging Machine has all the special features found in larger Alliance Machines.

This all-welded Charging Machine replaced obsolete charger and required no building reinforcements due to its lighter weight. **Strength was not sacrificed.**

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AMERICAN STEEL HOOP CO.	Youngstown, Ohio	
ILLINOIS STEEL CO.	Joliet, Ill.	1894
GEWERKSCHAFT DEUTSCHER KAISER	Dinslaken, Germany	1897
ACME STEEL GOODS CO.	Chicago, Ill.	1903
UNITED STEEL COMPANIES, LTD.	Sheffield, England	1918
TRUMBULL STEEL CO.	Warren, Ohio	1919
WHITEHEAD IRON & STEEL CO.	Tredegar, England	1919
SOC. ANON. DE LA CHIERS*	Longwy-Bas. France	1919
AMERICAN STEEL & WIRE CO.	Cuyahoga, Ohio	1924
SHARON STEEL HOOP CO.	Sharon. Pa.	1927
DOMNARFVETS JERNVERK**	Domnarvet, Sweden	1928
BROKEN HILL PROPRIETARY CO. LTD.***	Newcastle NSW, Australia	1948
ALGOMA STEEL CORP.****	Sault Sainte Marie, Canada	1949
		1950

*Mill also rolls rods **Mill also rolls rods and merchant shapes ***Mill also rolls skelp
****Mill also rolls merchant shapes

Sheet Bar Mills

YOUNGSTOWN SHEET & TUBE CO.	Youngstown, Ohio	
INDIANA STEEL CO.	Gary, Ind.	1905
SHARON STEEL HOOP CO.**	Sharon, Pa.	1911
LABELLE IRON WORKS	Steubenville, Ohio	1918
YOUNGSTOWN SHEET & TUBE CO.*	Indiana Harbor, Ind.	1921
McKINNEY STEEL CO.	Cleveland, Ohio	1923
McKINNEY STEEL CO.	Cleveland, Ohio	1924
LLANELLY STEEL CO.	Llanelly, Wales	1924
SOC. ANON. OUGREE-MARIHAYE*	Ougree, Belgium	1926
OESTERREICHISCHE ALPINE***	Leoben-Donawitz, Austria	1928
MONTANGESELLSCHAFT		1949
STEEL CORP. OF BENGAL, LTD.***	Burnpur, India	1950

*Mill also rolls skelp **Mill also rolls slabs ***Mill also rolls billets

Skelp Mills

YOUNGSTOWN SHEET & TUBE CO.	Youngstown, Ohio	
REPUBLIC IRON & STEEL CO.	Youngstown, Ohio	1906
JONES & LAUGHLIN STEEL CO.	Aliquippa, Pa.	1909
MARK MFG. CO.	Indiana Harbor, Ind.	1915
ALFRED HICKMAN, LTD.	Bilston, England	1916
BETHLEHEM STEEL CO.	Sparrows Point, Md.	1921
STEWARTS & LLOYDS, LTD.	Corby, England	1926
STEWARTS & LLOYDS, LTD.	Corby, England	1936
NATIONAL TUBE CO.	Morrisville, Pa.	1947
		1951

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Features which assure trouble-free operation and long life are incorporated in this 2,000 horsepower combination unit. All gears and pinions are precision generated by the famous Farrel-Sykes process. The first reduction gears and the mill pinions are herringbone type, while the second reduction consists of split (divided) double helical gears. This makes a compact arrangement which distributes the load uniformly and requires minimum floor space.

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Designed to suit individual requirements, Farrel rolling mill drives and pinion stands—separate or combination units—are available in any capacity. Farrel engineers will be glad to supply full information for any specific application.

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Type A switches have full interlock, visible blades and magnetic arc plate as well as a simple, quick-make-and-break mechanism, dead front line terminals, positive pressure fuse clips, multi-spring jaws, silver-plated current carrying parts and removable pressure connectors.

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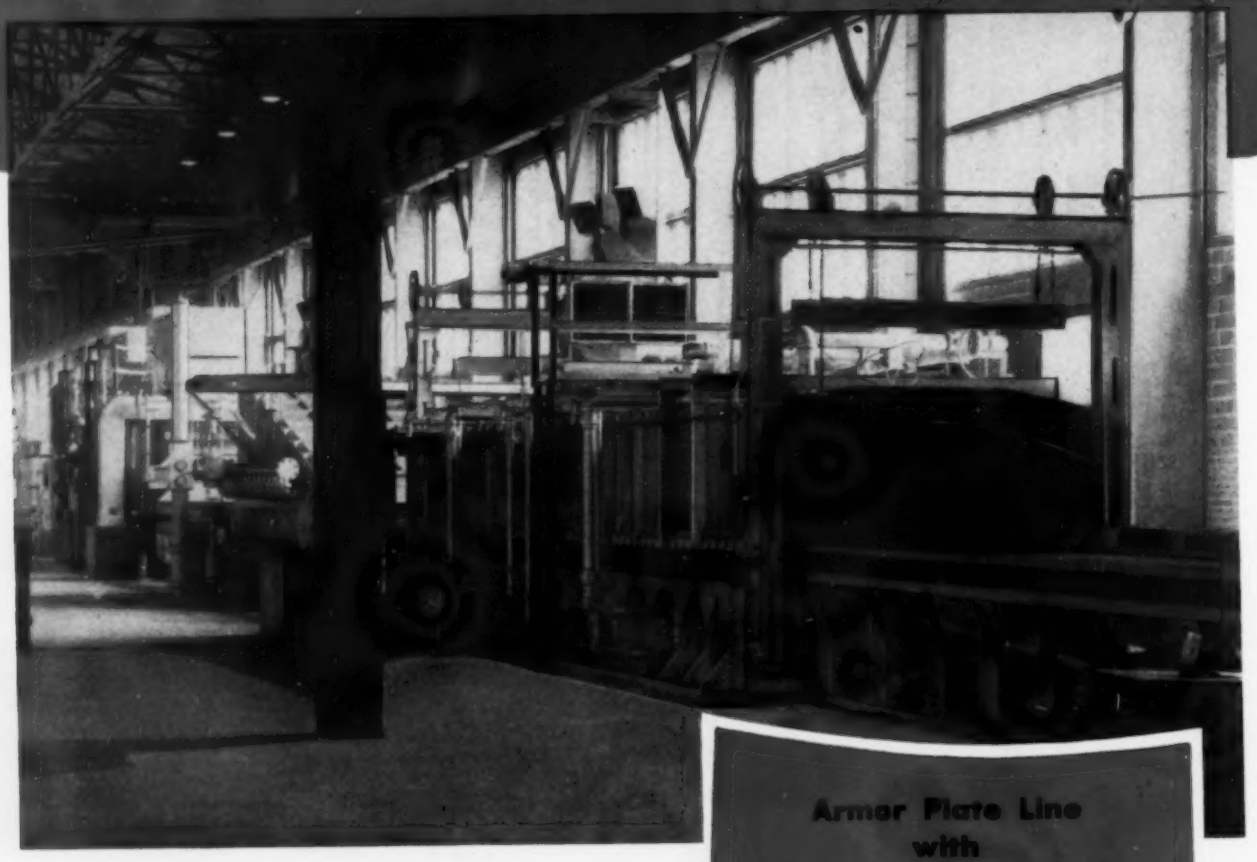

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RUST-OLEUM stops rust! Its tough, pliable, rust-resisting film gives excellent protection that prevents rust losses under many difficult rust-producing conditions.

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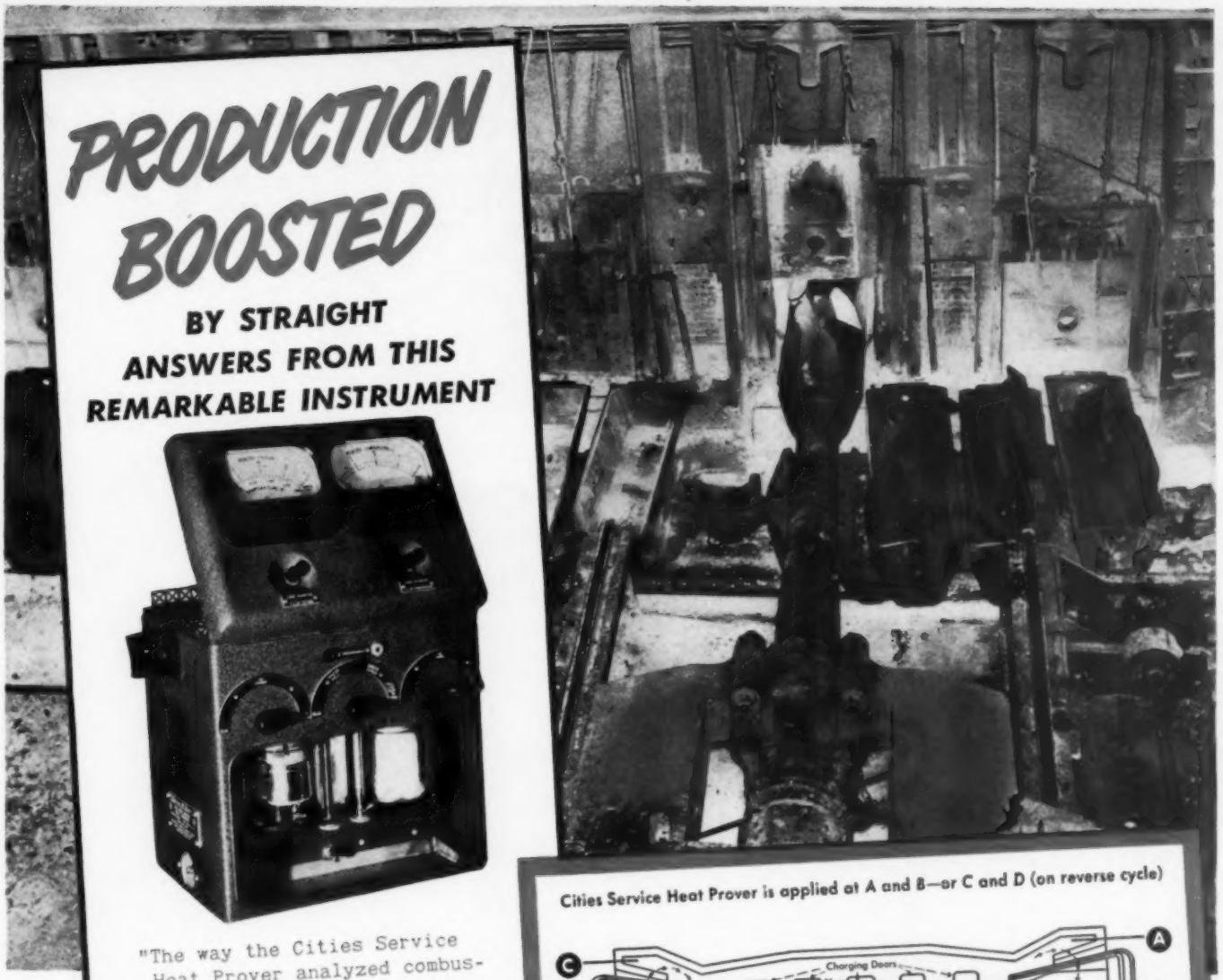

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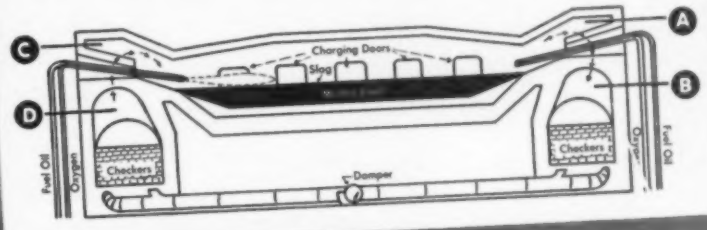

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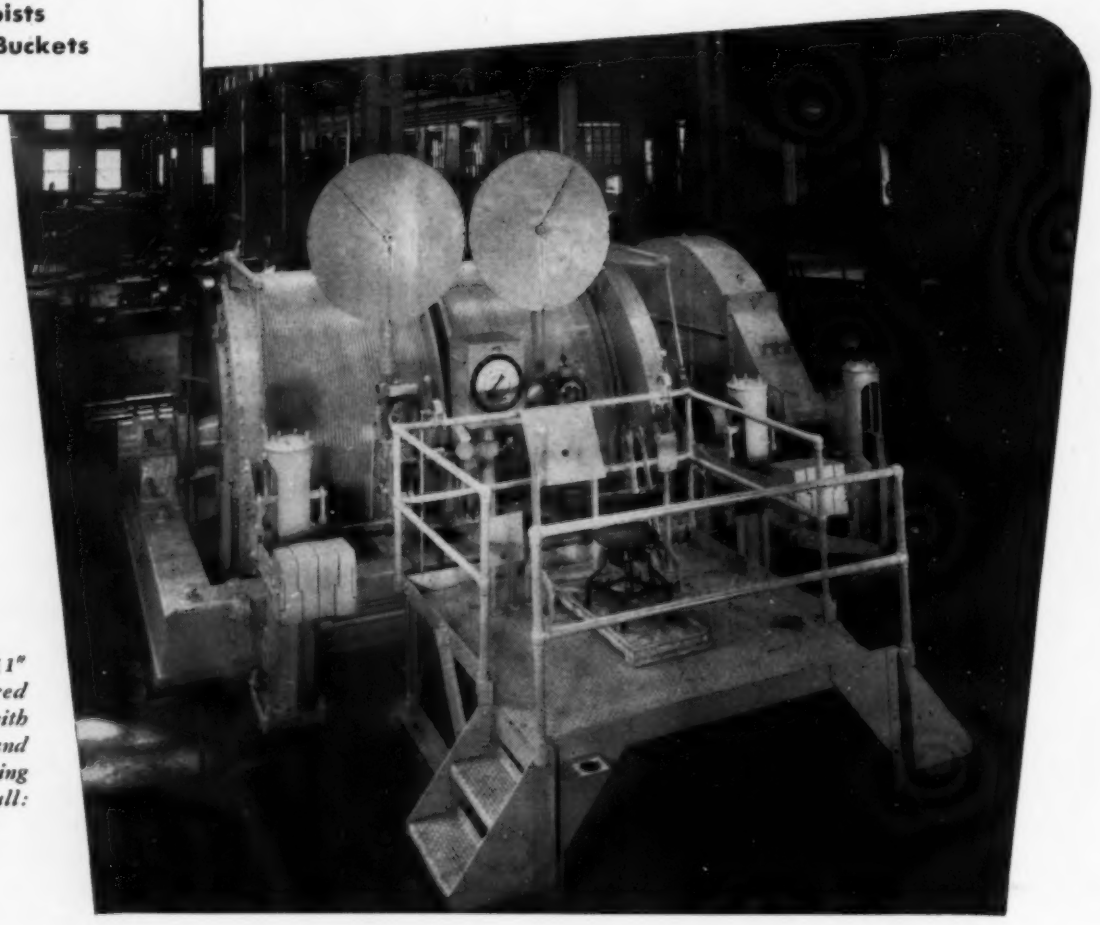

Wellman 10' x 4' 11" Double Drum Geared Electric Mine Hoist with 7' axial plate clutch and 10' x 13' Parallel Acting Brakes. Rated rope pull: 22,000 lbs.

● For more than half a century, in mines all over the world, Wellman Electric Mine Hoists have been used because they combine expert design with expert construction . . . featuring all the "modern improvements" developed in our 50 years' experience. Wellman Mine Hoists provide maximum safety, peak economy, and trouble-free operation under a wide variety of conditions. Let us give you recommendations for hoists that will do your job most satisfactorily.

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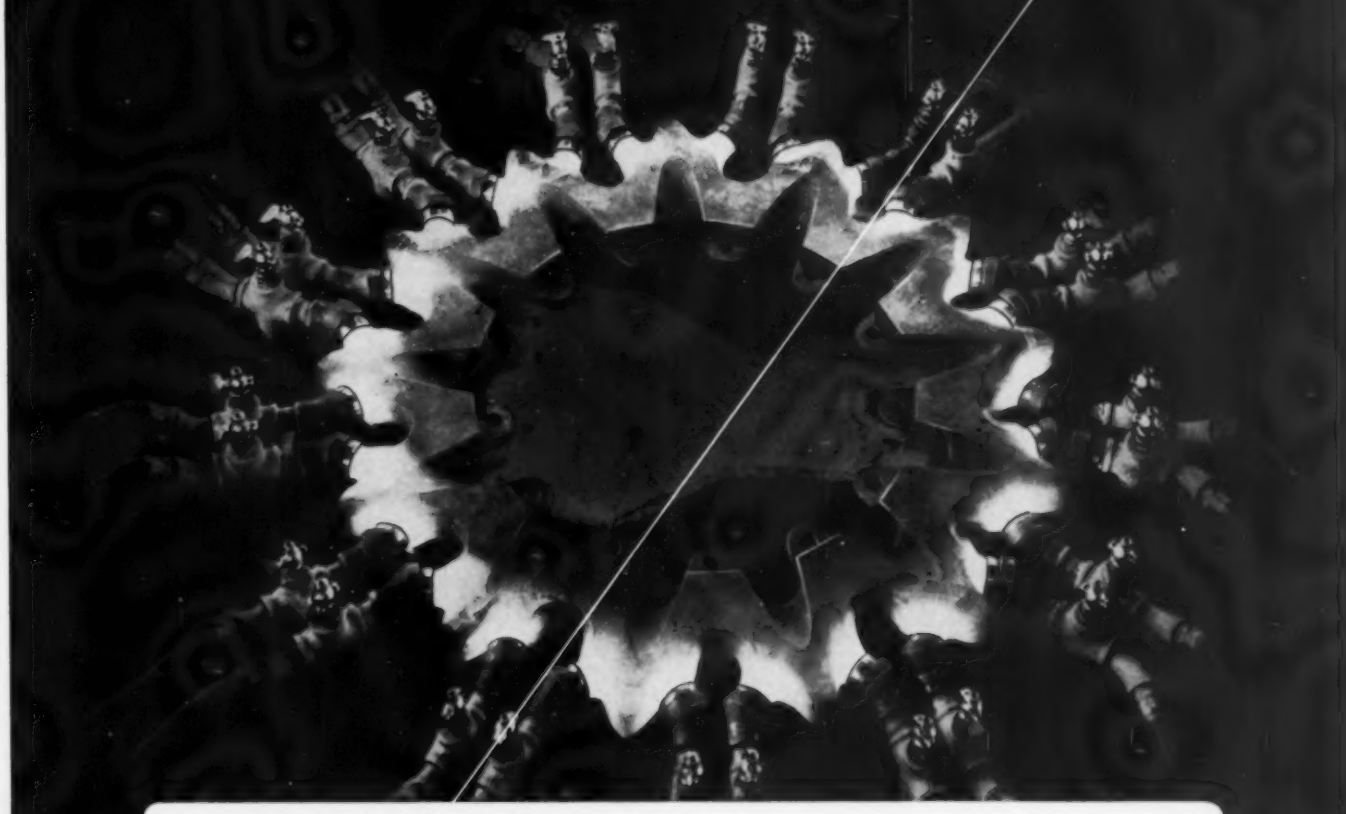
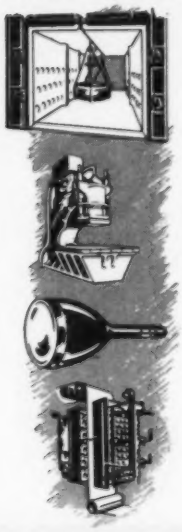
Toughening America's War Gears... *Faster*



Selas Production-Engineered-Processing makes Heat a Precision Tool for Greater Industrial Output



Tank gear teeth are toughened to the exact hardness required—in a matter of *minutes* with SELAS GRADIATION . . . *newest concept of high-speed heat processing* . . . proved during World War II, improved since.

WHEREVER PRODUCTION REQUIRES PRECISION HEAT PROCESSING, SELAS GRADIATION IS REVISING PRODUCTION RATES AND QUALITY—*upward.*

This precision tool utilizes radiant heat . . . combines high temperatures, automatic operation, precise controllability and protective atmospheres.

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Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

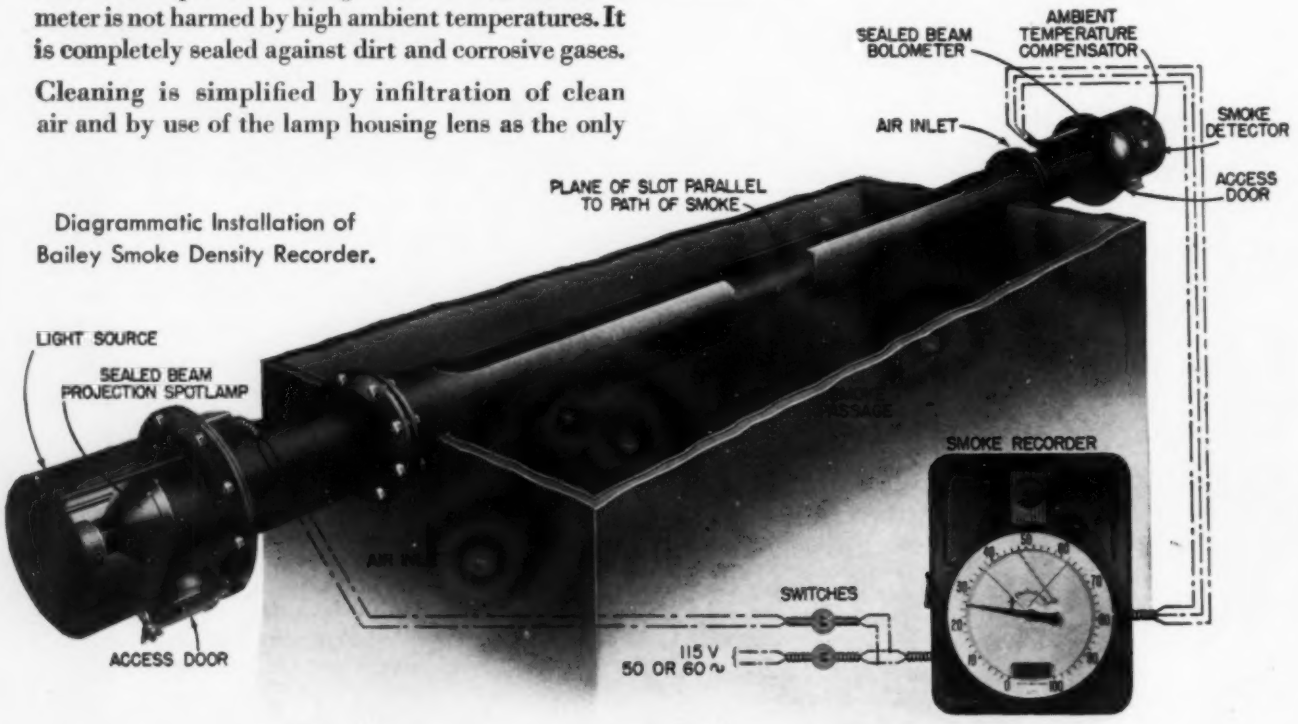
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

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BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

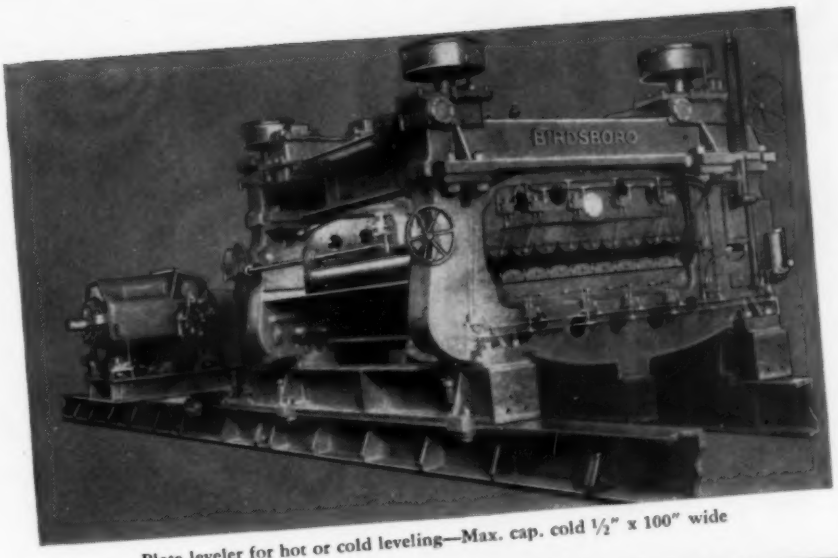
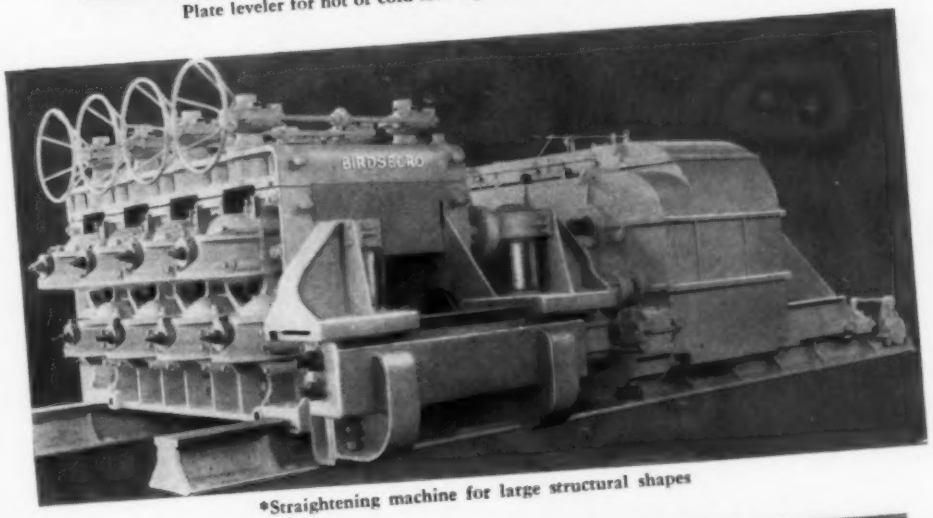


Plate leveler for hot or cold leveling—Max. cap. cold ½" x 100" wide

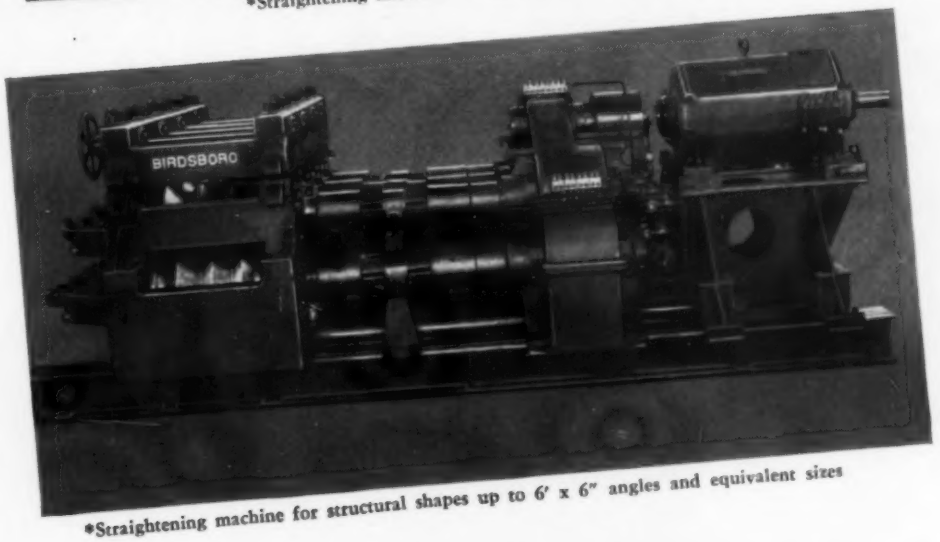
TO SPEED UP

Your Straightening Jobs



*Straightening machine for large structural shapes

Leveling heavy steel plates, or straightening large structural shapes can be costly and time-consuming, unless the machines you use are efficient. Perhaps one of these Birdsboro straightening machines will meet your requirements. Or perhaps, you will need a specially designed straightening machine to secure maximum results at minimum cost.



*Straightening machine for structural shapes up to 6' x 6" angles and equivalent sizes

Birdsboro design engineers have had diversified experience in designing, straightening and leveling machines. Take advantage of their skill to obtain the equipment you need to do your straightening jobs best.

* Straightening machines are equipped with our "patented" end roll equipment.

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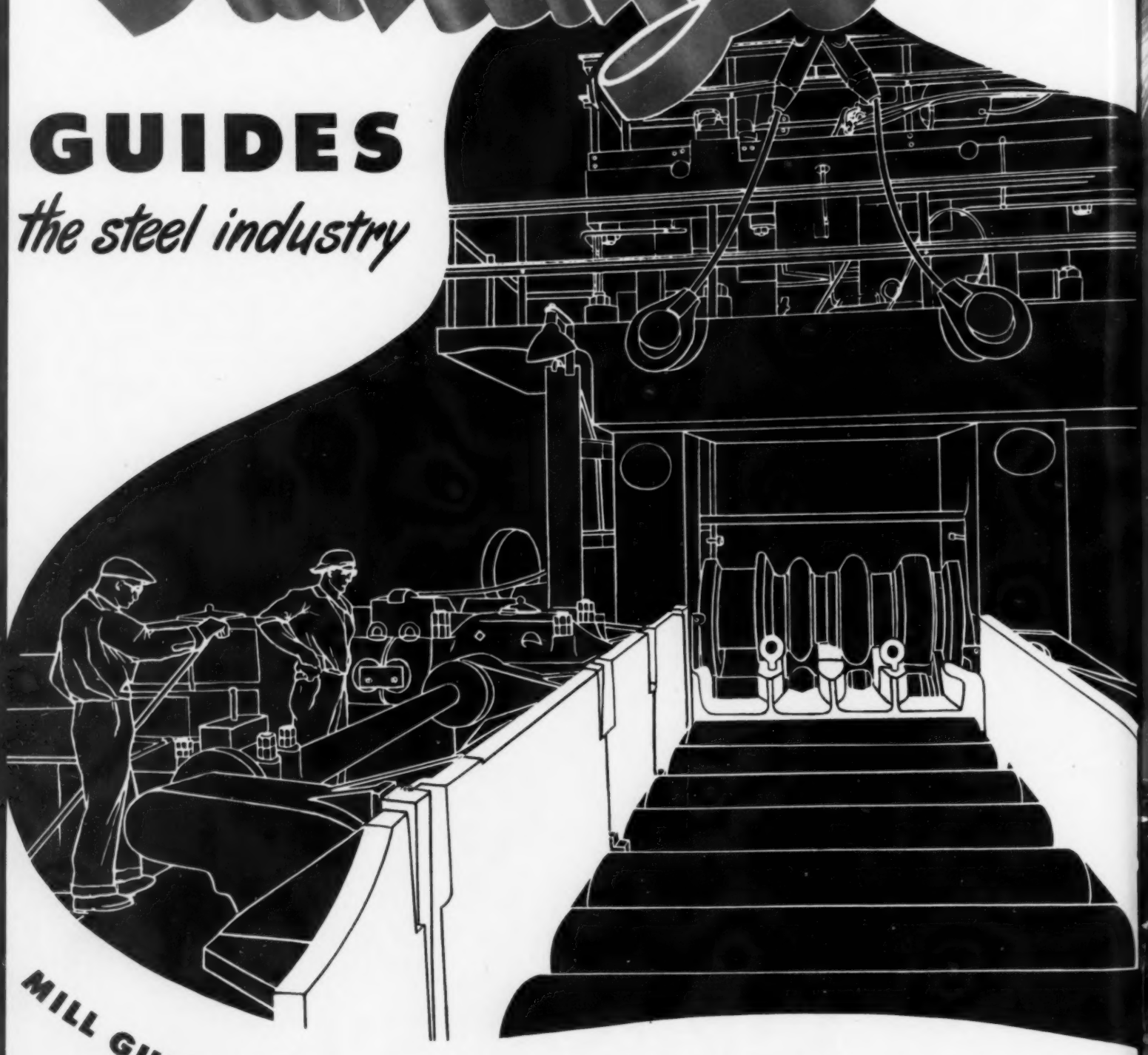
GUIDES

the steel industry



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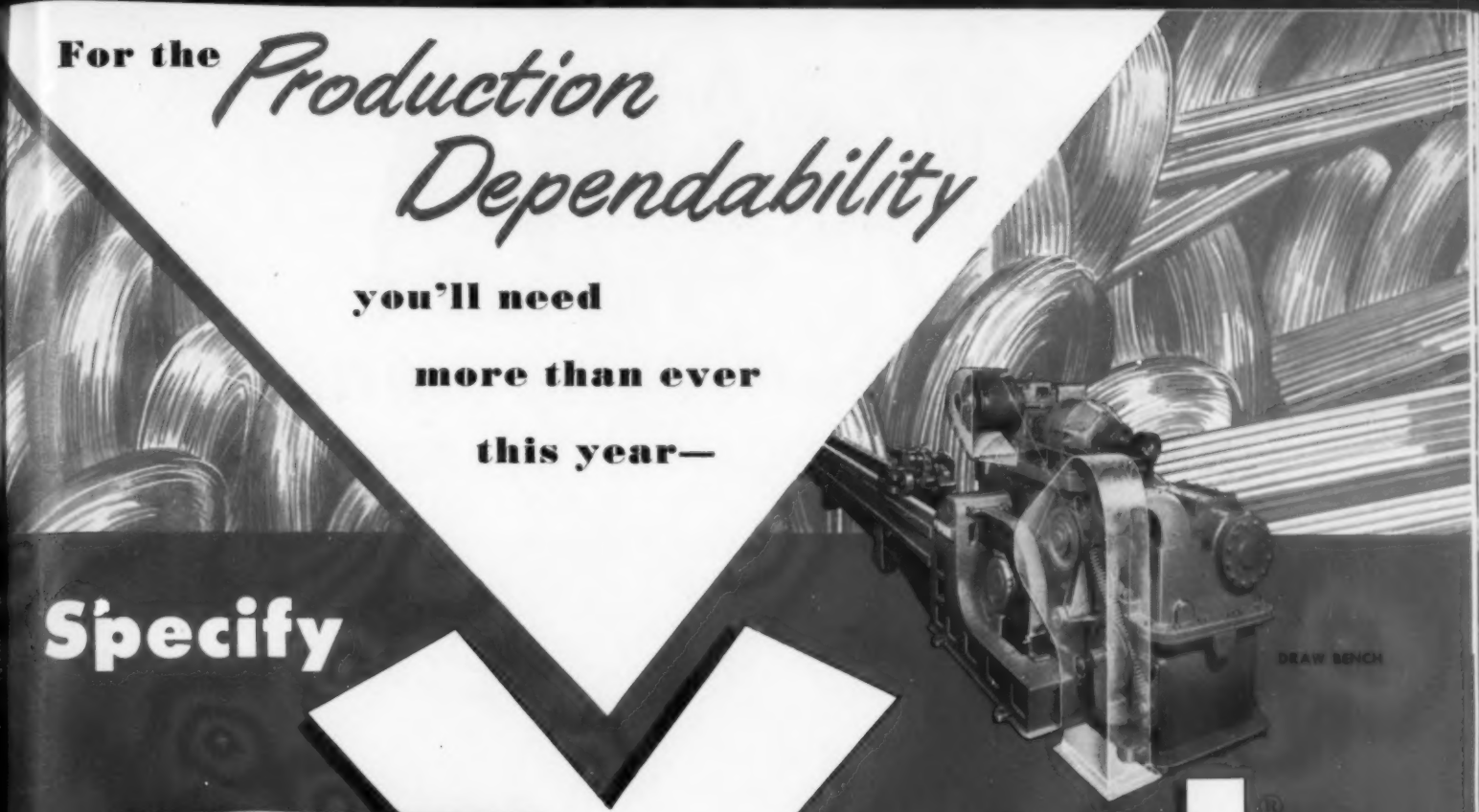

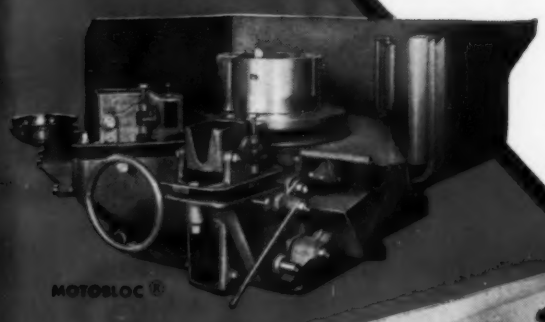

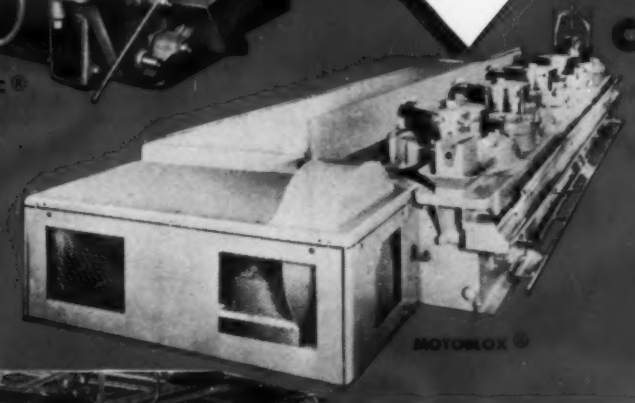

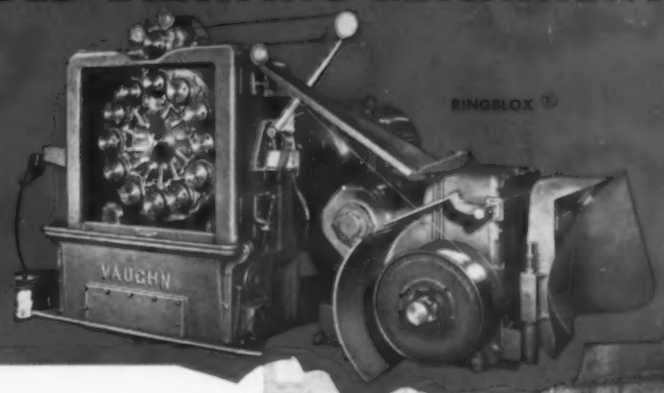

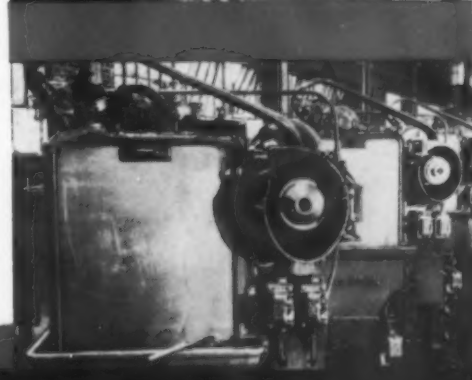

Whether your need is for a single Motobloc or a battery of integrated wire drawing machines—one small draw bench or the largest in the field—call in Vaughn for the recommendations, quotations, installation facts and figures that will give you the *dependable* solution to your production problems!

The Vaughn Machinery Co.

Cuyahoga Falls, Ohio, U.S.A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

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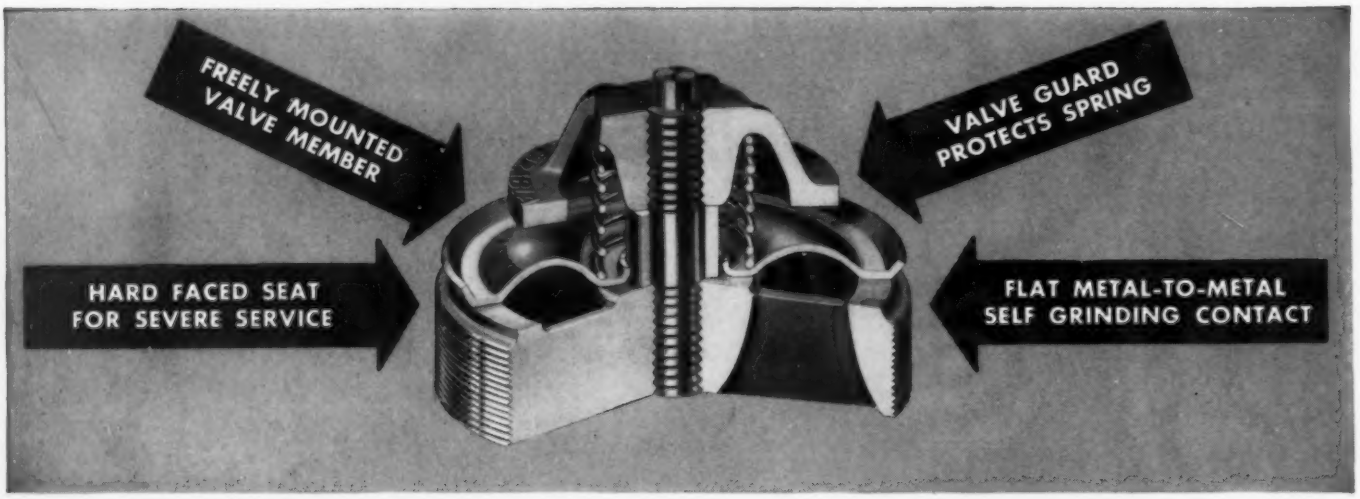
KEEP YOUR PUMPS IN SERVICE


FREELY MOUNTED VALVE MEMBER
VALVE GUARD PROTECTS SPRING
HARD FACED SEAT FOR SEVERE SERVICE
FLAT METAL-TO-METAL SELF GRINDING CONTACT

1 **THEY ARE SELF-GRINDING:** Durabla Valve Units*, utilizing the freely mounted arched construction valve member exclusive to Durabla, are self-grinding, as the flat portion of the valve member is in direct contact with the flat valve seat and is free to move about its axis, thus producing a constant self-grinding action.

2 **VALVE SEATS ARE HARD FACED FOR SEVERE SERVICE:** Providing a seat surface hardness of Rockwell C-48-52 (approximately 500 Brinnel) or more in special valves, Durabla Valve Units have a long record of effective service with FLUIDS CARRYING SUSPENDED ABRASIVE SUBSTANCES. The metal valve member effectively prevents the pitting or "pick-up" of abrasive substances sometimes occurring with valves made of other materials.

3 **VALVE SPRINGS AND VALVE STEMS ARE PROTECTED:** The Valve Guard protects the Valve Spring from ever compressing more than 50% of its length. The Valve Stem is protected against breakage by the free mounting of the Valve Member.

Economy, efficiency and adaptability, based on long established service records and exclusive design make Durabla Valves your guarantee of reliable, uninterrupted pump operation.

You can specify Durabla Valves when you order a pump, (many manufacturers use them as standard equipment), or you can order Durabla Valves to fit any type of reciprocating pump, (they come with drive-fit seats or threaded seats with or without a shoulder to suit the job).

TO AVOID "PUMP TROUBLES" SPECIFY DURABLA VALVES

Address DURABLA Engineering Department for information and bulletin: Reference IS 5

*Patent Numbers 2090486, 2117504

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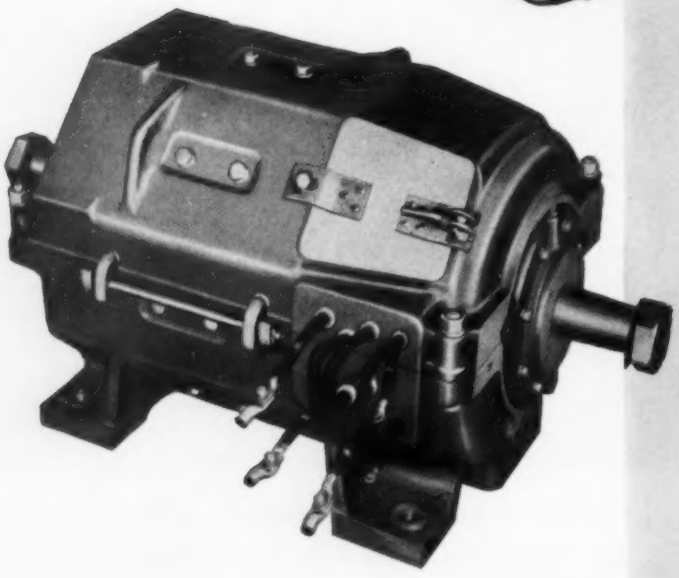
Whether your order calls for castings "in the rough" or machined to close tolerances, "Union" always comes through with exactly what the customer requires — *plus* an extra measure of quality due to casting practices and techniques developed and acquired in over 50 years' experience.

"Union" makes better: — GEARS AND PINIONS . . . TONGS AND TONG LEVERS . . . UNIVERSAL COUPLINGS AND SPINDLES . . . CHARGING BOXES . . . PEELS . . . SLAG POTS . . . INGOT AND CHARGING BOX CARS . . . SPECIAL UNIVAN AND ARMOR STEEL CASTINGS.

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.



Seven Basic Reasons

WHY THIS MILL MOTOR WILL SET NEW STANDARDS OF PERFORMANCE IN YOUR PLANT

1. BETTER COMMUTATION: Brushes with ample current-carrying capacity—properly designed commutator—specially shaped commutating pole faces.

2. UNIT ASSEMBLY OF FIELD COILS: Formed coil completely insulated and then assembled on a steel shell to protect coil from grounding or chafing against the pole.

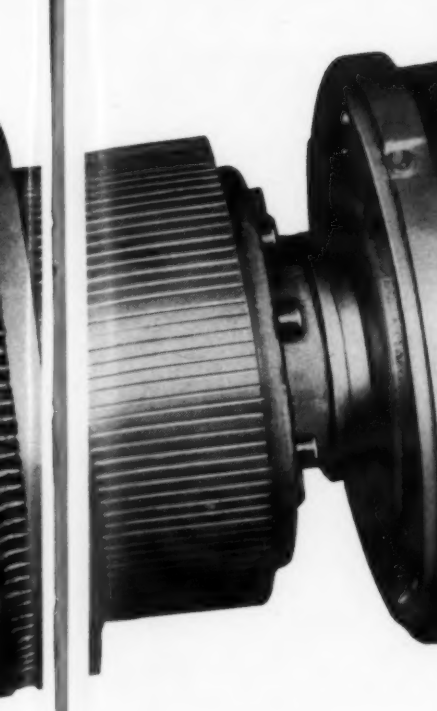
3. HIGHER MAXIMUM SAFE SPEEDS: Anchoring of armature coils with individual wedges permits safe operation at higher speeds—no core bands to come loose and cause trouble.

4. HEAVIER AXLE STEEL SHAFT: Larger in diameter between the bearings, on horsepower basis—made possible by mounting punchings directly on the shaft which is removable.

5. RIGIDLY MOUNTED COMMUTATOR: Bridge construction supports each end of commutator on shaft—no overhang.

6. CAST-ALUMINUM FAN: One piece—large diameter provides a plus in cooling.

7. LOW-INERTIA ARMATURE: Allows motor to start, stop and reverse with minimum stored energy.



Look — No Core Bands!

Wedges give you the toughest mill motor built

Wedges, instead of bands, hold the armature coils firmly in place on the new Westinghouse Series 600 Mill Motor. This means a stronger armature that is capable of safe operation at higher speeds . . . increased motor efficiency.

Broken core bands are destructive, also core bands can cause damage to the insulation on armature coils during assembly. Wedges eliminate this risk—make winding a simple operation. Each slot has its own individual wedge . . . made of Class B material. Simplifies servicing and repair work.

Further, complete insulation of the armature provides maximum electrical strength. Mica wrapper and glass tape protect the conductor. Complete armature assembly is impregnated with thermoset varnish. All this adds up to a rugged armature for a strong motor—built to handle your toughest jobs.

There are many more advantages offered by this mill motor that you will want to consider. Your Westinghouse representative has all the facts. Ask him for your copy of Booklet B-4730. Or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21646

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For the greatest value in dependably superior crane performance that your purchase dollar can buy, look to "Shaw-Box."

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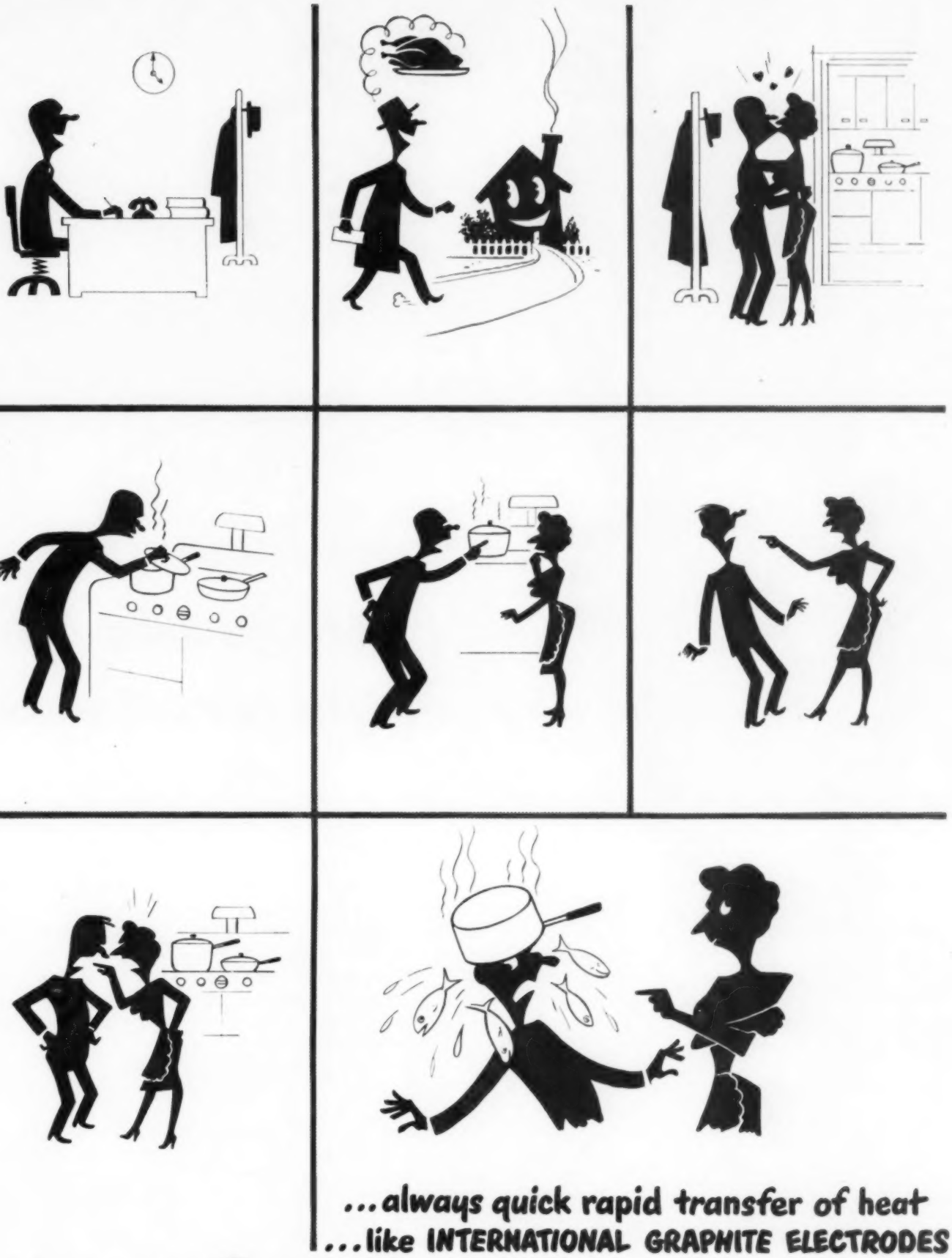

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...like INTERNATIONAL GRAPHITE ELECTRODES

INTERNATIONAL Graphite & Electrode CORP.

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ST. MARYS, PENNSYLVANIA

new OKOPRENE end seal

waterproofs multi-conductor cable terminals

● One of the most common sources of difficulty with control, signal, and communication cables is at the termination of the over-all outside covering of the assembly. In most cases this is due not to any shortcomings of the cable itself, but to unsatisfactory methods of moisture-proofing the end of the cable.

Okonite now offers a waterproof End Seal which eliminates the most troublesome cause of such failures: moisture. The Okoprene End Seal is cone shaped (shown above), to receive filling compound, and snugly fits over any cable sheath from ¾" to 2" in diameter. Compound does not leak, and hardens to form a neat, permanent, moisture-proof seal.

Terminating by this means is a quick, simple operation. It eliminates the use of friction tape or windings which often allow moisture to be trapped under the outer covering.

Made from the neoprene formula used in rugged Okolite-Okoprene cables, the Okoprene End Seal provides the same high degree of permanence as the cable itself. It is mechanically strong, and resistant to light, air, ozone, oils and chemicals, as well as to moisture. It is adaptable to new or existing cables having lead sheath, interlocked armor, braided or other types of over-all coverings.

Use Okolite-Okoprene cable with the Okoprene End Seal on your next installation for completely trouble-free service. For details on the Okoprene End Seal, write for Bulletin IS-2091 to The Okonite Company, Passaic, N. J.

THE BEST CABLE IS YOUR BEST POLICY

OKONITE SINCE 1878 insulated wires and cables

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MANUFACTURERS OF
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FOR THE IRON, STEEL AND
NON-FERROUS
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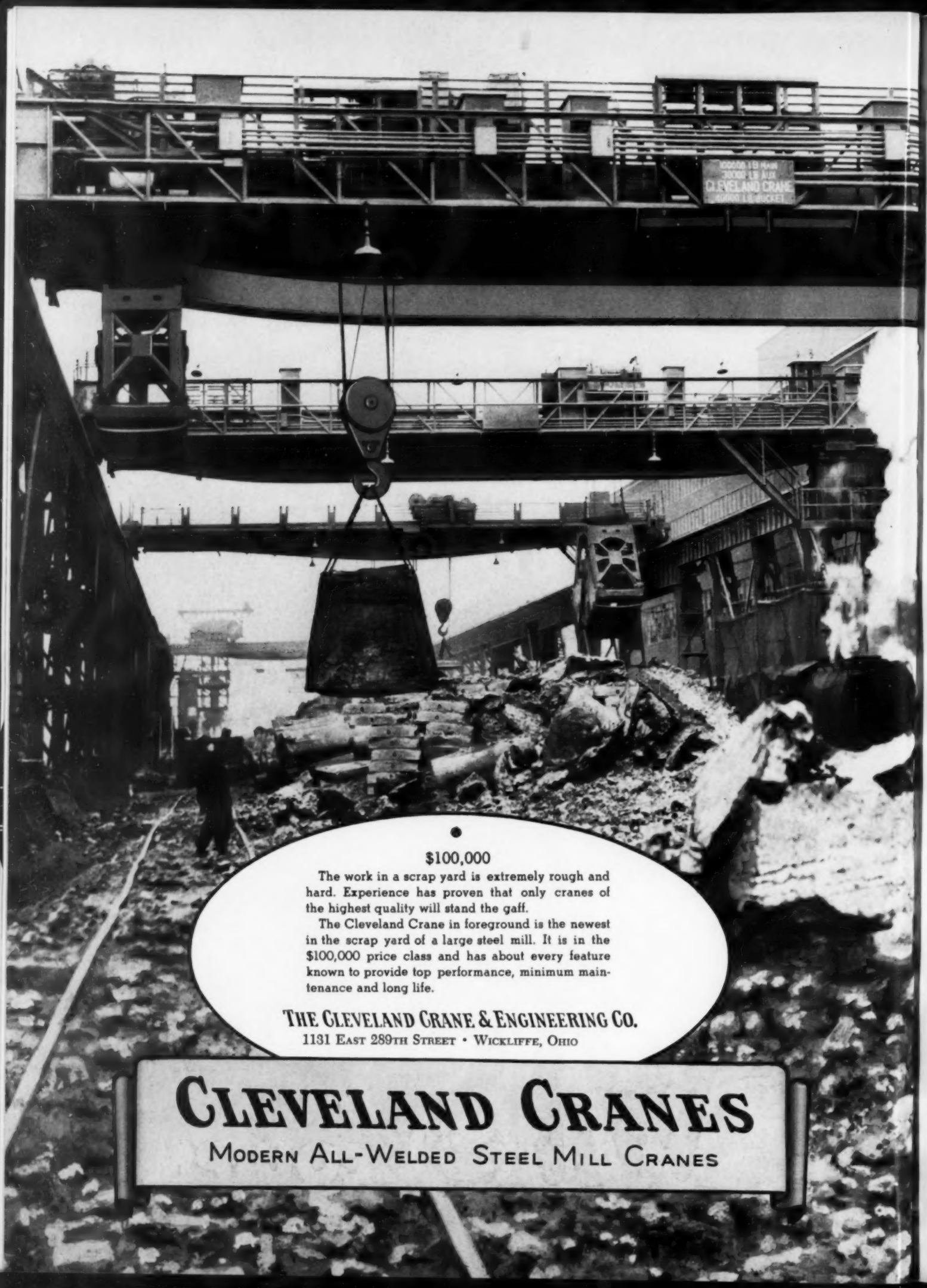


$100,000

The work in a scrap yard is extremely rough and hard. Experience has proven that only cranes of the highest quality will stand the gaff.

The Cleveland Crane in foreground is the newest in the scrap yard of a large steel mill. It is in the $100,000 price class and has about every feature known to provide top performance, minimum maintenance and long life.

THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 289TH STREET • WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

UP to mid-April, more than 1000 certificates of necessity have been issued by Defense Production Administration for expansion projects in all industries. These projects have a total value of approximately 4.6 billion dollars. The average allowance for rapid amortization is 70 per cent. Pennsylvania, Texas, Ohio, Connecticut, and New York lead the parade of states in value of projects.

▲

SEVERAL of the steel expansion projects so ambitiously announced during recent months are being abandoned. The reason generally given is that new capacity already under way and fully financed should be ample to meet requirements. Some projects are encountering the deadline on the 120-day life of their certificates of necessity. Some extensions have been granted to give more time to complete financing and permit the start of construction.

▲

A CORRESPONDENT tells us that work is what when we have it, we wish we didn't; when we don't have it, we wish we did; and the object of it is to be able to some day afford not to have to do any more of.

▲

GWILYM PRICE, president of Westinghouse Electric Corp., told a group of trade magazine and newspaper men that the most acute shortage is not in materials or supplies, but in technically trained engineers with five to fifteen years of experience. Addressing the same group, A. C. Monteith, Westinghouse vice president, said that industry should accept the responsibility of training the new engineering graduate to aid in his transition from the general principles of science and engineering taught in the colleges into the practical application of that knowledge in industry.

▲

SOMETIMES the mink in the window brings the wolf to the door.

▲

E. T. WEIR, chairman of National Steel Corp., believes that 1951 earnings will be less than those of 1950 despite full production. Mr. Weir also stated that the decision on whether or not National will build an eastern plant is a year away. There is belief in some quarters that another large plant cannot be started in that area until completion of the Fairless works releases a lot of skilled construction labor.

ACCORDING to the American Iron and Steel Institute, employment in the iron and steel industry set a new record at 662,700 in February. Hourly payments to wage earners averaged $1.916, and total payroll was estimated at $219,412,000 for the month.

▲

THE publishers of seed catalogs that show those gorgeous flowers and vegetables should think up sequels to send out in July to restore the high enthusiasm occasioned by the first editions.

▲

BLAST furnaces in the United States set a new production record in March, according to the American Iron and Steel Institute. Operating at 97.7 per cent of capacity, the furnaces produced 6,015,662 tons of pig iron and ferroalloys, of which 5,946,312 tons was pig iron. First quarter production was also a record at 17,077,785 tons, including 16,884,395 tons of pig iron.

▲

VOLUME I, Number 1 of the First Iron Works Gazette, published by the First Iron Works Association, an organization working to restore what is believed to be the first successful iron works in America at Saugus, Mass., contains an interesting item concerning the old ironmaster who in 1646 obtained permission from Massachusetts Bay Court to purchase old guns to be resmelted. The Gazette says this was probably the first use of scrap iron in America for resmelting purposes. We'd say the old ironmaster was out to set a production record.

▲

A MAN that makes too many mistakes usually gets fired (that is, unless he belongs to a union). A company that makes too many mistakes goes bankrupt. A government that makes too many mistakes goes right on borrowing money to make more.

▲

CLOSE upon the heels of the announcement of termination of merger talks between Allegheny Ludlum Steel Corp. and Pittsburgh Steel Co. comes news that the latter company has purchased a 66 in. continuous hot strip mill.

▲

ROBERT W. WOLCOTT, president of Lukens Steel Co. and chairman of the scrap committee of the American Iron and Steel Institute, stated that steel mill scrap supplies are "dangerously low," with current reports showing a 21-day supply instead of the more usual 60-day inventory.

Plants in some districts report as little as 5/10 days supply.

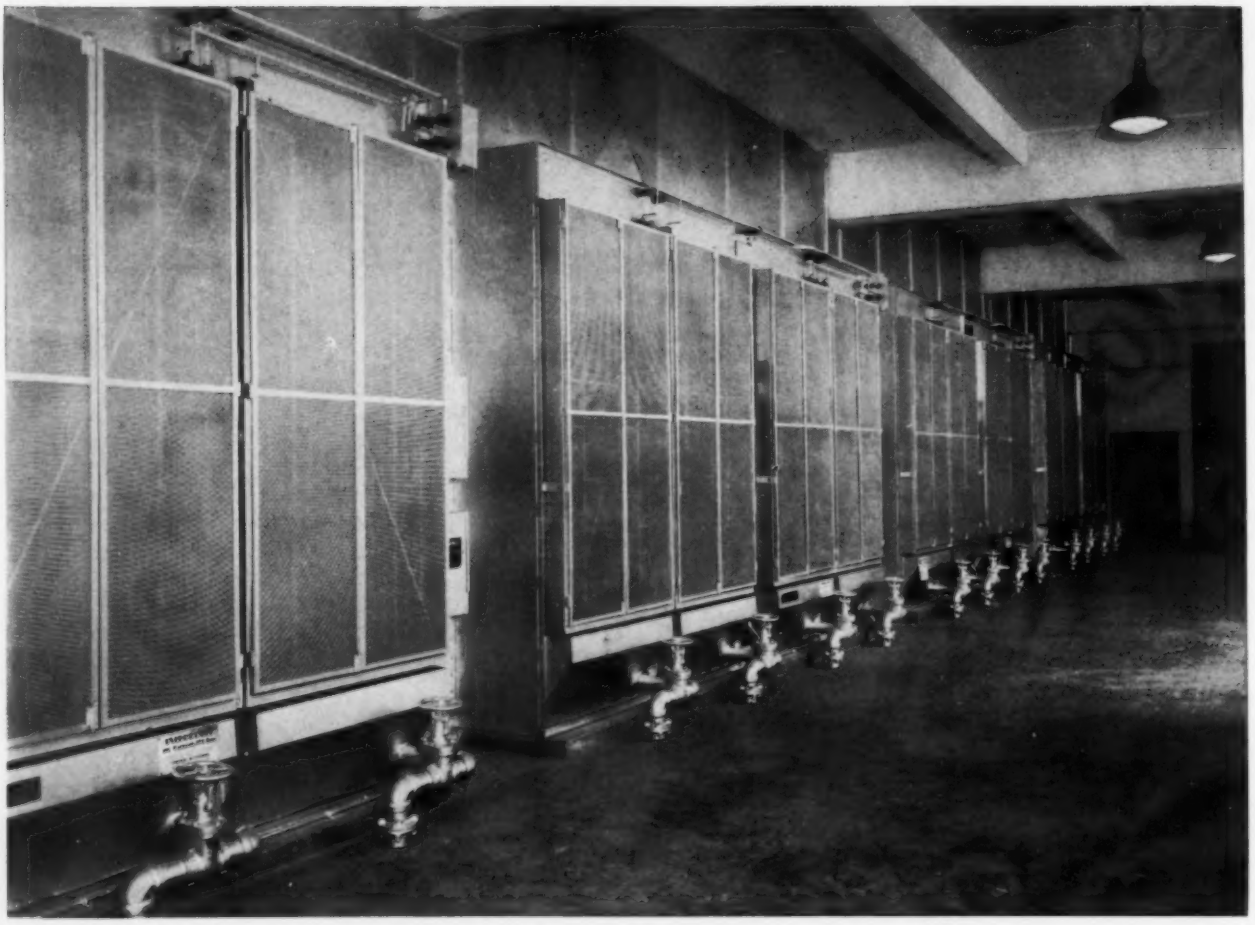
▲

GOVERNOR DAN THORNTON of Colorado says "Socialism has given the people of England false teeth for free but no meat to chew on."

▲

IN 1950, 35,500 Americans were killed in traffic accidents, and 1,799,800 more were injured. About 75 per cent of the traffic accidents happened in clear weather and on dry roads.

today's best buy is better air!



AAF Electro-Matic *Precipitators totaling 175,000 CFM*

Electro-MATIC super-clean air

. . . MEANS LESS MAINTENANCE FOR MILL MOTORS!

STEEL MILL MOTORS perform more efficiently with less maintenance, if the cooling air is *super-clean.* Electro-Matic*, the *only* automatic, self-cleaning, electronic precipitator is widely used by steel mills to provide dust-free air for their motor rooms.

Highest cleaning efficiency is maintained by the Electro-Matic over a wide range of particle sizes, from smoke to the largest air-borne material. Due to the special design and spacing of its collector plates the filter curtain is non-clogging and insures uniform air volume. Also, the Electro-Matic's exclusive features of automatic operation and self-cleaning, reduce servicing to routine maintenance and insure maximum operating efficiency at all times.

The filters are standardized, self-contained sections, easily installed in various arrangements to meet any air volume requirements. Like so many in the steeel industry, the Electro-Matic installation above is equipped with oil clarifiers, which continuously clean the Viscosine and simplify sludge removal.

With thirty years experience in solving dust problems, AAF makes the *only* complete line of air filters and electronic precipitators. If *super-clean* air for motor rooms or other operations is one of your problems, call your nearby AAF representative or write today for Engineering Bulletin No. 250-E.

**ELECTRO-MATIC Automatic Electronic Precipitator.*

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American Air Filter

COMPANY, INC.

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WHY ARE MORE BRISTOL RECORDING GAUGES BEING USED THAN ALL OTHERS COMBINED?

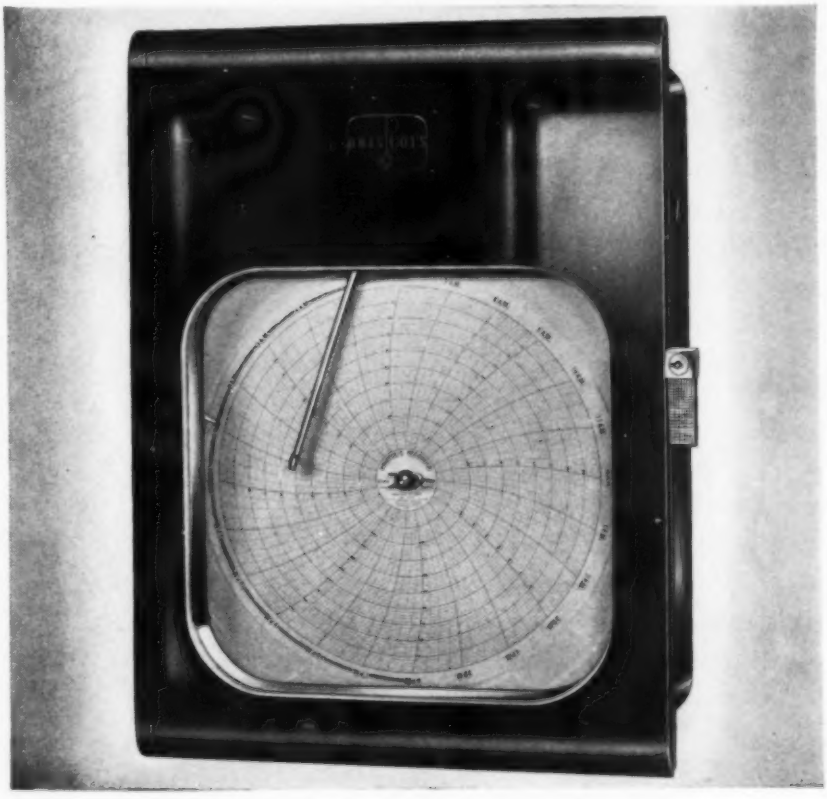
The heart of the pressure gauge is the pressure measuring element.

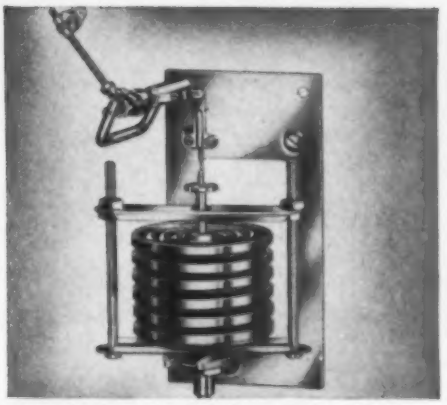
Hundreds of thousands of Bristol recording gauges in use all over the world, operating under all kinds of conditions, testify to the high accuracy, long life, and permanent calibration of Bristol's element.

Many Bristol gauges have been in constant service for 20, 30 and 40 years!

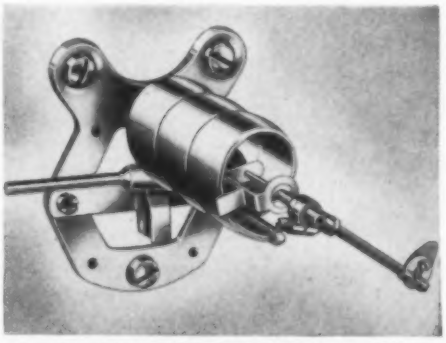
Now Bristol presents its *new* line of Series 500 recording pressure gauges in ranges from 0 to 6 millimeters mercury absolute to 0 to 10,000 psi. They have many outstanding new features which make them easier to use, convenient to service, readily convertible. And they incorporate the three most advanced designs of measuring elements.

Models are available for recording, automatic controlling, pneumatic transmission and telemetering. Immediate delivery on many ranges. Write for new 32-page Catalog G621. THE BRISTOL COMPANY, 123 Bristol Road, Waterbury 20, Conn.

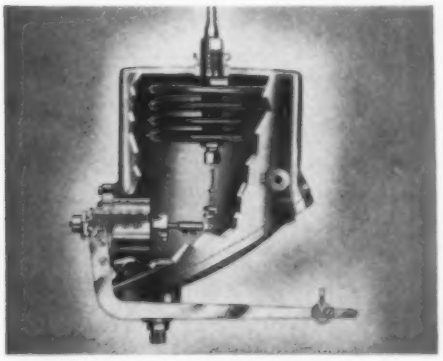




FOR LOW PRESSURE RANGES—new Type E measuring element is used for ranges from 0-2 in. water to 0-29.9 psi pressure or vacuum. Extremely high torque gives positive pen positioning across entire range. Highly accurate, extremely stable. 250% inherent over-range protection.



FOR INTERMEDIATE AND HIGH RANGES—new helical measuring element is for ranges from 0-30 psi to 0-10,000 psi. Special nonferrous alloy—heat-treated to withstand impact of rapid fluctuations—gives permanent accuracy over a long period of service life.



FOR ABSOLUTE PRESSURE—new single-bellows type element measures ranges as low as 0-6 mm. mercury absolute and gives direct reading of pressure above absolute zero inherently corrected for barometric variations—with far greater accuracy than ever before.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

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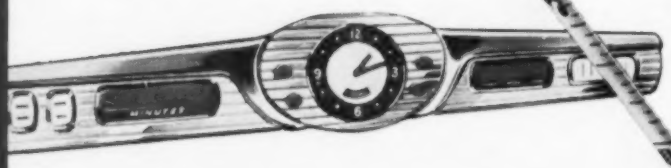
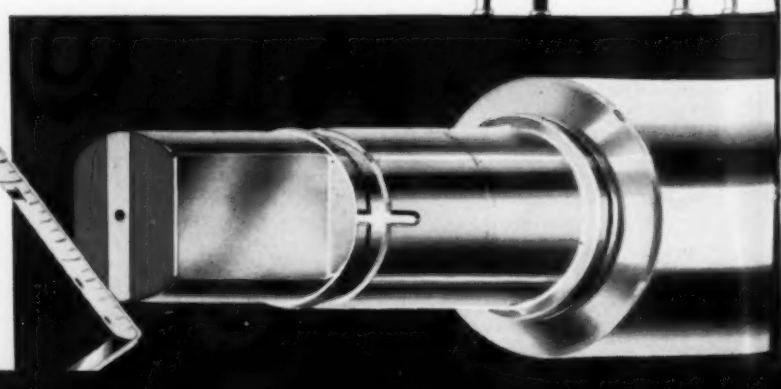
keeps automatics active and well fed

You'll find the familiar Mack-Hemp yellow-striped red wabbler rolls hard at work on the toughest jobs in efficient modern cold-rolled strip mills. In fact, Mack-Hemp strip mill rolls have been constantly improved to provide the productioneering tools required during the two decades when the demand for cold-rolled strip pyramided from 347,458 tons in 1931 to 1,591,038 tons in 1949.

From start to finish in rolling of strip, Mack-Hemp rolls are dependable producers in every operation. And, M-H engineers and metallurgists are engaged in continuous research and testing programs to provide striped red wabbler rolls which will stand up under ever-changing rolling conditions. That's why it's always important to keep an eye on what's new at Mack-Hemp.





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Iron AND Steel ENGINEER

MAY, 1951 VOLUME XXVIII NUMBER V

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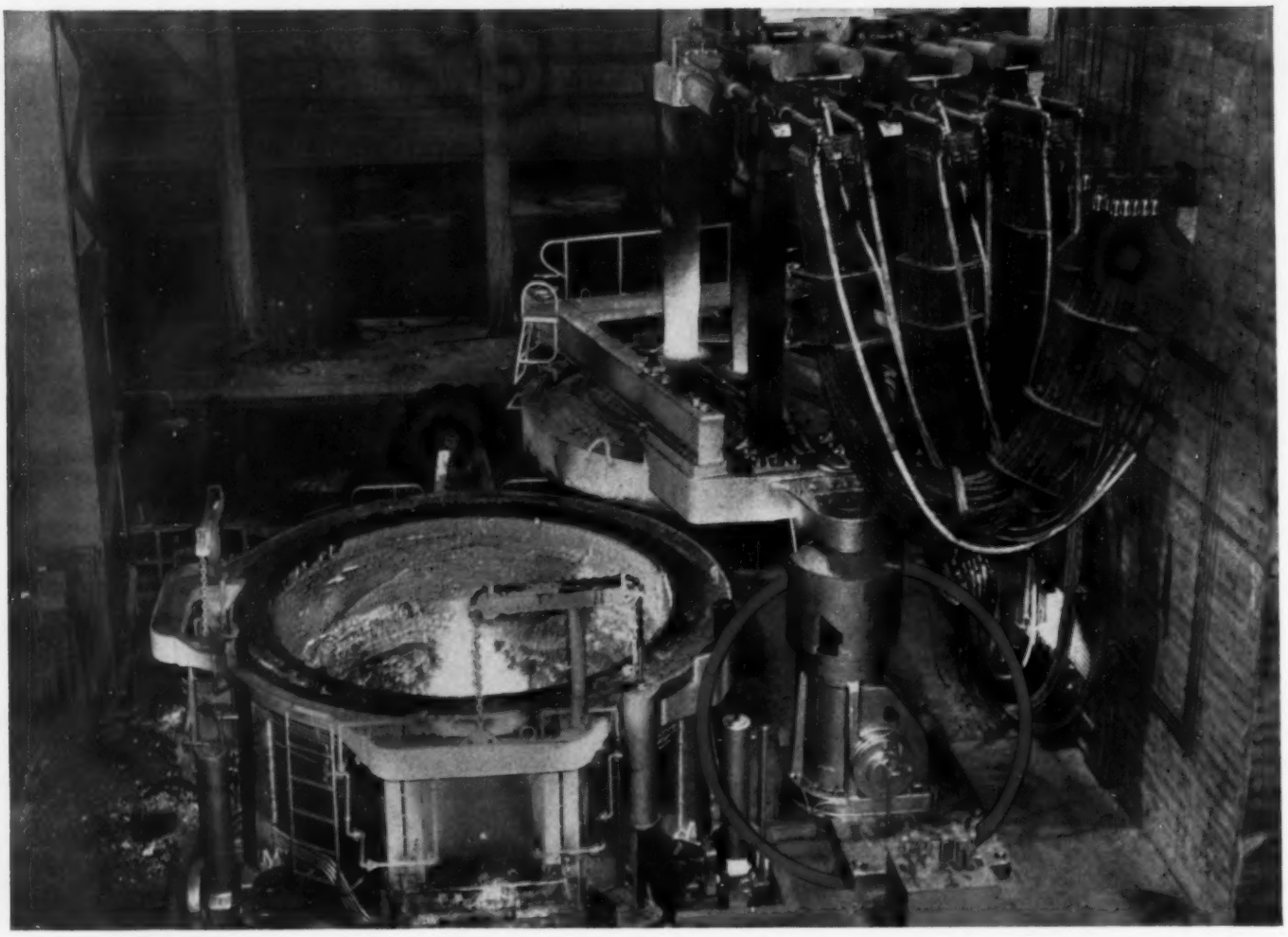

Its swinging roof has its feet firmly planted on the ground

You swing a lot of weight—and fast—when you open a Lectromelt Furnace for charging. But that weight is carried on a foundation completely independent of the furnace itself, so the support is rigid and there's no strain on the shell.

Because every ounce of the sturdy top structure of a Moore Rapid Lectromelt Furnace rides on massive oil bearings, it swings aside easily and smoothly. No chatter to shake roof bricks loose.

This combination helps make Lectromelt electric arc furnaces the best choice for melting, refining, smelting and reduction. For more details on these furnaces, write for Catalog No. 8. Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

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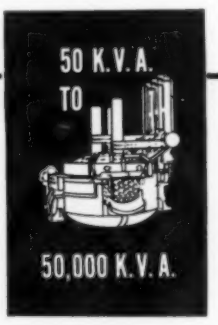
MOORE RAPID

WHEN YOU MELT... ***Lectromelt***



Rolling of Tool Steels

By H. C. BIGGE
Superintendent of Tool Steel Division
Bethlehem Steel Co.
Bethlehem, Pa.

. . . . the rolling of tool steel is an art which requires experience, control and care . . . .

▲ TOOL steel manufacture is an involved and exacting process. Every phase of production must be closely controlled and great care exercised to maintain a high quality product.

Tool steels may be divided into six classifications, giving a simplified and balanced grouping of standard types as follows:

1. Carbon and carbon-vanadium steels.
2. Oil-hardening and air-hardening tool and die steels (Table I).
3. Shock-resisting steels (Table II).
4. High-speed tool steels (Table III).
5. Hot-work tool steels (Table IV).
6. Special purpose steels.

The choice provided by these groups ranges from all-purpose steels to special selections to satisfy varying or predominating requirements such as wear resistance, toughness, non-deforming qualities, red hardness, and machinability.

All Bethlehem tool steels are made by the basic electric furnace process. One 28-ton and two 50-ton furnaces are used in the production of the lower alloy steels and the carbon and carbon-vanadium grades.

High-speed, air-hardening, hot-work steels and similar grades are made in a 7-ton basic arc furnace equipped for top charging (Figure 1), with modern hydraulic roof lift to speed up charging, and an automatic, continuous electrode regulator to maintain the desired power input and facilitate carbon control. Production from the 7-ton furnace is normally cast into hot-topped ingots from 9 to 16 in. square, weighing from 700 to 3200 lb. Experience has proved that a 90 per cent reduction in area from ingot to finished bar is required to reduce and distribute the carbides in high-tungsten and high-carbon chromium air-hardening (high-alloy) types of steel. The ingots are forged on a 6-ton hammer.

The ingots of the high alloy type, immediately after stripping, are charged into gas-fired preheating furnaces and held until their temperature is 1400 to 1650 F throughout. See Figure 2. The carefully preheated ingots are transferred to a three-chamber, gas-fired furnace, Figure 3, and slowly brought to a forging temperature of 2100 to 2300 F, depending upon the composition. They are then reduced to billets on a 6-ton steam hammer equipped with a charging machine and a manipulator (Figure 4). The billets are buried in

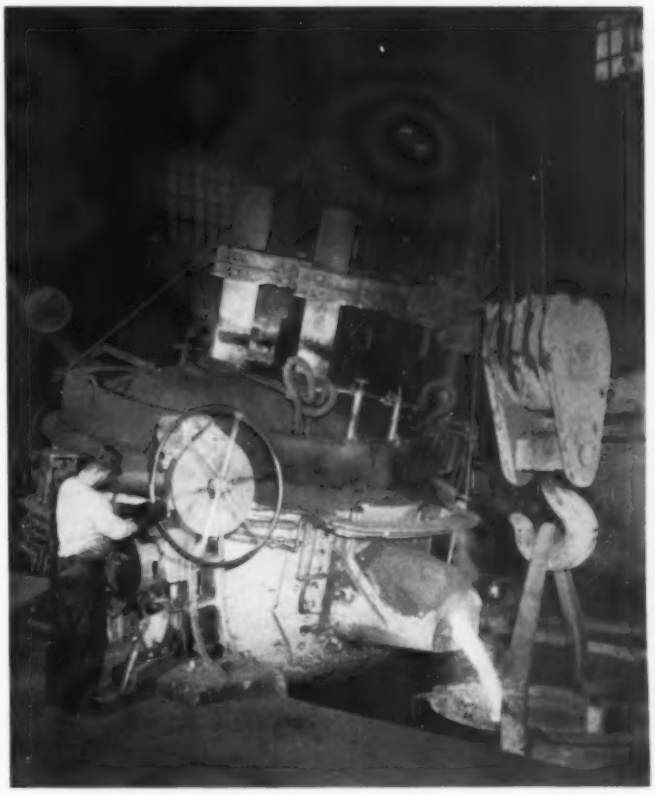


Figure 1 — The high speed, air hardening and steels of similar grades are made in a 7-ton basic arc furnace.

diatomaceous earth for slow cooling for as long as 100 hours. They are then annealed at approximately 1400 F in a bung-type furnace, with pyrometer control and combination oil and gas firing.

The annealed billets are tested for internal defects by hot-acid etching. They are then ground (Figure 5) to remove surface imperfections prior to further reduction on smaller steam hammers or on rolling mills. Some of the largest sizes may first be given additional breakdown on a 16-in. roughing mill, followed by controlled cooling, annealing, and spot grinding.

Four forging hammers of 1000, 1500, 2500, and 4500-lb capacity are available. The 2500-lb hammer uses overhead crane-operated tongs shown in Figure 6, while the two smaller units are manually operated. The

TABLE I

Industry type	Bethlehem trade name	Approximate analyses, per cent						
		C	Mn	Ni	Cr	Mo	V	W
Oil hardening—Mn, Cr, W	B T R	0.90	1.20	....	0.50	....	0.20	0.50
Oil hardening—Ni, Cr, Mo	Bethalloy	0.75	0.75	1.75	0.90	0.35	....	....
Air hardening—2 per cent Cr	B A H	1.00	2.00	....	2.00	1.00	....	....
Air hardening—5 per cent Cr	A H S	1.00	0.75	....	5.00	1.00	0.25	....
Air hardening—High C, high Cr	Lehigh—H	1.55	0.40	....	11.50	0.80	0.40	....
Oil hardening—High C, high Cr	Lehigh—S	2.10	0.40	....	11.50	....	0.60	....

TABLE II

Industry type	Bethlehem trade name	Approximate analyses, per cent							
		C	Mn	Si	Ni	Cr	Mo	V	W
Si, Mn, Mo, V	Omega	0.60	0.70	1.85	...	...	0.50	0.20	...
Cr, W, V	67 Chisel	0.50	0.30	0.80	...	1.20	...	1.20	2.50
High C—High Cr	Lehigh—L	0.85	0.40	0.50	1.00	11.50	0.50	0.30	...

TABLE III

Industry type	Bethlehem trade name	Approximate analyses, per cent				
		C	W	Cr	V	Mo
M—2	66 High Speed	0.83	6.00	4.00	2.00	5.00
18-4-1	Special High Speed	0.73	18.00	4.00	1.00	....
18-4-3 High carbon	Red Tiger	1.00	18.50	4.50	2.50	....

TABLE IV

Industry type	Approximate analyses, per cent					
	C	Si	Cr	Mo	V	W
Cr, Mo, W	0.35	1.00	5.00	1.50	.....	1.50
Cr, Mo, V	0.35	1.00	5.00	1.25	0.50	.....
Cr, W	0.35	0.30	2.75	.....	0.30	9.00
Mo	0.60	0.30	3.60	8.50	1.75	

largest of these (Figure 7) is equipped with a 3-ton manipulator charging machine and turntable.

All heating furnaces are of the twin-chamber type, with steam atomized-oil firing, and are capable of heating 1 to 10-in. square billets from room temperature to 2300 F. Three of the furnaces have rated capacity of 800 lb of steel per hour, the other two 1000 lb each. The firing is controlled manually, the furnace pressure automatically. After forging, the billets or bars are covered with diatomaceous earth for slow cooling.

Billets from the 6-ton hammer are rolled on a 16-in. mill. The air-hardening types of tool steels are rolled to the billet sizes shown on Figure 8, the lower alloy content steels to those shown on Figure 9.

The highly alloyed tool steels are more sensitive in heating and have different rolling characteristics than

Figure 2 — High alloy ingots are held in a preheating furnace until their temperature is 1400 to 1650 F.

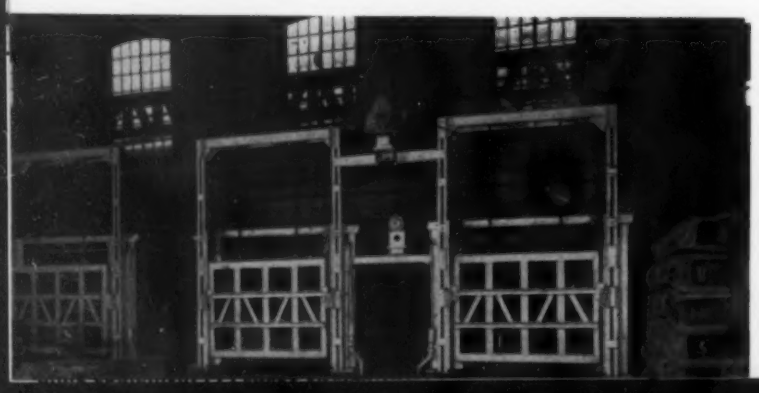


Figure 3 — Preheated ingots are brought to forging temperature of 2100 to 2300 F in a three-chamber furnace.

the lower alloy types, due to their air-hardening properties. These steels are, therefore, cast into smaller ingots, hammered into billets which are again rolled or forged into smaller size billets, before they are rolled or forged to finished bar sizes. The speed of the mill is slower than the speed of the mills rolling carbon steel or low-alloy steel. This is necessary to insure proper entrance of the tool steel into the various roll passes.

The mill is served by two heating furnaces, see Figure 10, one a continuous type oil-fired unit, the other a two-compartment type, oil-fired furnace with automatic controls. The continuous furnace servicing the 16-in. and 12-in. mills has a hearth 50 ft in length. The skids are made of heat-resisting steel measuring 9 in. by 3 in. These require no water cooling, and therefore provide uniform heating without any cold spots. Billets up to 6¼ in. square by 7 ft long, of 1080 lb maximum weight, may be charged. The furnace is divided into a preheating zone where the cold billets are brought up to 1400 F and a heating zone where the temperature is raised to 2150 to 2200 F. Full automatic control of temperature, furnace pressure, and air-fuel ratio is maintained in both zones.

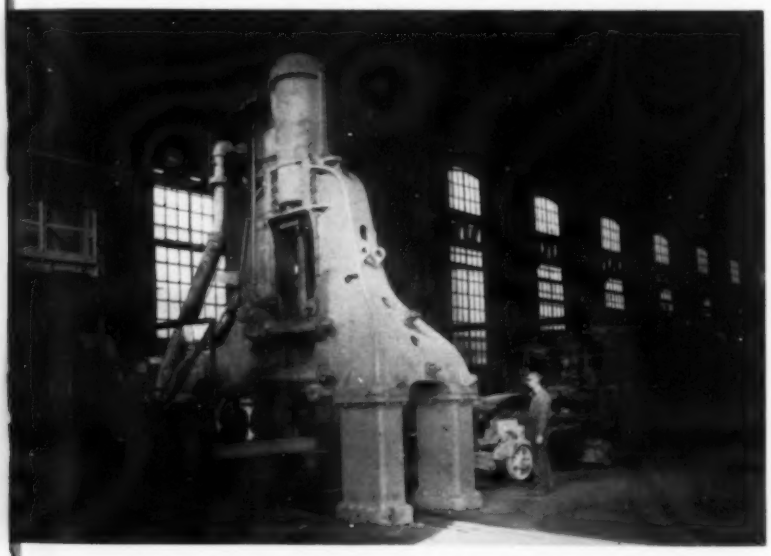


Figure 4 — Ingots are reduced to billets on a 6-ton steam hammer.

The heating furnace for the 9-in. mill includes a single-chamber unit and one double-chamber unit equipped for oil firing, with pyrometer control in each chamber, and automatic pressure regulation.

The 12-in. mill, shown in Figure 11, is a conventional Belgian mill, complemented by a two-stand, 16-in., 3-high rougher. The 12-in. mill itself has five 3-high stands and one 2-high stand. The 9-in. mill is also a Belgian mill consisting of one 3-high 12-in. roughing stand and five 3-high and one 2-high finishing stands. The motors are as follows:

16-in. 2-stand rougher: Electric drive, 350-hp induction motor, 3-phase 25-cycle. Speed 125 rpm minus 15 per cent only by sodium carbonate slip regulator.

12-in. 6-stand finishing mill: Electric drive, 350-hp induction motor, 3-phase 25-cycle. Speed 145 or 96 rpm.

The rougher for the 9 in. mill is a 12-in. single stand rougher: Electric drive, 350-hp induction motor, 3-phase 25-cycle. Speed 125 rpm.

The 9-in. mill has a 6-stand finishing mill: Electric drive, 560-700-840-hp induction motor. Speed 294 rpm base, plus or minus 15 per cent equipped with a specially designed regulating set operated by 150-hp induction motor, 1470 rpm.

Figure 5 — Surface imperfections are removed from the annealed billets by grinding.

Decarburization can be markedly reduced in rolled tool steel bars by decreasing the length of time that the billets are held in the various sizes of mill reheating furnace, and by heating them rapidly to the rolling temperature. If properly controlled, this can be done without any detrimental internal or external effects on the bars. We have found by experimenting with atmospheric control that it is possible to produce finished bars with a minimum amount of decarburization. However, such rapid heating is even more practical and reliable on a production basis. The recommended times are based on charging the annealed billets into a hot furnace held at 50 degrees above rolling temperature. Table V is a detailed schedule of heating times used for the various types of billets.

The heating times for various size billets given in the table were calculated for a rolling temperature of 2150 F. However, they may be applied to any rolling temperature without appreciable error, provided the differential between the furnace temperature and the ultimate billet temperature (rolling temperature) remains constant. The 50 degree F temperature differential between the furnace temperature and the ultimate billet temperature is the controlling factor. A greater temperature differential will materially shorten the time

Figure 6 — A number of small forging hammers are available.

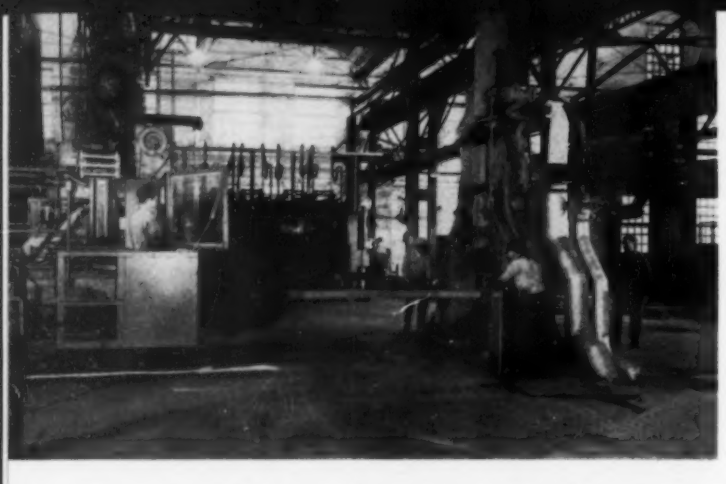


Figure 7 — This hammer is equipped with a 3-ton manipulator charging machine and turntable.

necessary to reach rolling heat. If the temperature differential is less than 50 degrees F, the time necessary will be increased. The values given in the table are minimum and maximum times required for uniform heating of the various size billets. When the elapsed furnace time exceeds the minimum values, it is advisable to check the furnace and make sure that the differential between rolling temperature and furnace temperature is not greater than 50 degrees F. In no case should the maximum time be exceeded if minimum surface decarburization is to be attained.

The calculation of these heating times is based on the work of T. F. Russel, published, by the Iron and Steel Institute in Special Report No. 14, First Report of the Alloy Steels Research, Research Committee, 1936.

The calculated heating times for the various grades of tool steels has been applied in the 9-in. and 12-in. mills since the early part of 1946 and are giving a satisfactory product under actual operation conditions.

The following sketches show the design of some of the passes required in rolling tool steel grades. For comparison a sketch showing the passes used for rolling steel of lower alloy content is also included. It may be seen that special size billets and additional passes are required for rolling the special compositions and regular tool-steel grades, if a satisfactory product without torn edges and within size tolerances is to be obtained.

The upper part of Figure 12 shows a method of rolling 4-in. square hammered tool steel billets into $2\frac{1}{8}$-in. round billets which subsequently are used for re-rolling into squares, flats, and rounds, as shown in the billet schedule (2-in. rounds are made by the same method). The $2\frac{1}{8}$-in. billets are placed in the electric holding furnace (Figure 13) as they are rolled, then transferred to the controlled-cooling furnaces (Figure 14) and cooled to room temperature at the rate of 20 degrees F per hour. They are transferred to an annealing furnace and annealed at about 1400 F, slow cooled and surface inspected. The ends are then cut and tested, they are also spark tested, shot blasted and spot ground or rough turned, and returned to the 9-in. and 12-in. mills for re-rolling into finished bar sizes. Re-rolling of the $2\frac{1}{8}$-in. billets to $\frac{13}{32}$-in. rounds is shown in the lower half of Figure 12.

Figure 15 shows a special method for rolling a difficult composition of valve steel possessing high heat-resistant properties. The processing of this steel from ingot to finished bar requires special manufacturing on account of the narrow hot working range and the limited amount of reduction in area per pass. The ingots for this grade are hammered to 4-in. square billets, slow cooled, annealed and ground using special grinding wheels for surface preparation. Grinding serrations must be removed by hand grinding and polishing the surface to remove these before rolling into finished bars. The 4-in. billet is rolled with light reduction of area per pass as illustrated by the doubling up or repeating in each pass in order to square the section. For this reason more passes are therefore required in rolling this special grade.

Figure 16 gives a comparison of passes used in rolling high alloy tool steel and alloy steel grades. A total of 16 passes is required when starting with a hammered 4-in. square, high-alloy tool-steel billet, to produce bars of $1\frac{1}{8}$-in. diameter (upper part of figure). The lower section shows the conventional method of using 98-degree breakdown passes for rolling steel of lower alloy

Figure 8 — Chart gives billet sizes required for finished bar sizes for air hardening type steels.

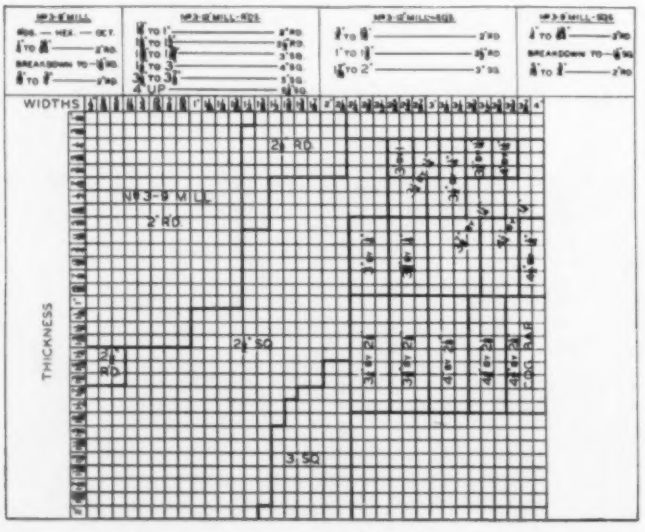
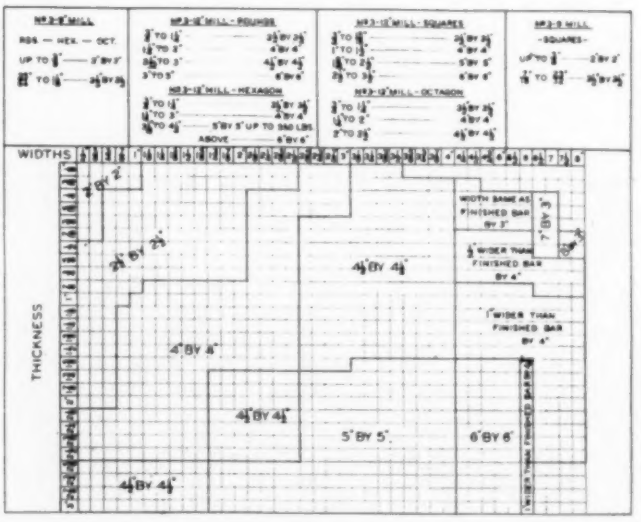


Figure 9 — Chart gives billet sizes required for finished bar sizes for alloy steels.



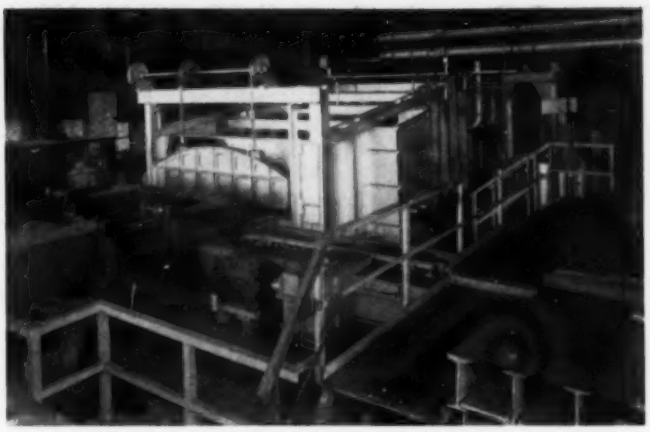


Figure 10 — Two heating furnaces serve the 16-in. and 12-in. mills.

Figure 11 — The 12-in. mill is a conventional Belgian mill.

content, starting with a 4-in. square rolled billet and finishing to the same size (1⅛-in.) in 14 passes. It will be noted that the upper part of the chart, starting with No. 6 pass, shows special passes that change the corners of the billets. This method is designed to give rapid reduction of area and produce finished bars without roll tears.

Figure 17 shows a comparison between rolling hand rounds of the tool steel grades and steels of lower alloy content. For tool steels a 5½-in. square billet and 15 passes are required to produce a 4⅛-in. diameter finished bar, whereas with low-alloy steels a rolled 6¼-in. square billet is reduced to a 4⅛-in. diameter bar in 10 passes.

The upper part of Figure 18 shows a special method of making a 9/16-in. square, high-speed tool-steel bar. A 2⅛-in. round billet is broken down in diamond, square and oval passes and finished to 9/16-in. squares in a total of 10 passes. This method produces high speed steels free from surface tears. The low-alloy steel, shown in the lower part of the figure, is rolled from a 2½-in. square billet in the conventional diamond and square passes to finish to the same size and section in 12 passes. The smaller round billet used for the tool steel enables us to produce the 9/16-in. squares in 10 passes.

Figure 19 compares the passes used in rolling tool steel and low-alloy steel to 1⅛-in. square finished bars. The 2½-in. square tool steel billet, previously produced from a larger billet, is rolled to finished size in 16 special passes. The alloy finished bar, also 1⅛-in. square, is produced in 12 passes from a 4-in. square billet, using standard passes.

The upper part of Figure 20 shows a special method of rolling 1 × 2 in. high-speed steel flats. To prevent torn edges, it is necessary to start with a 2 × 3 in. hammered billet and roll by the method shown. Lower-alloyed steel can be produced to the same size, from regular 4-in. square rolled billets, with 5 of the 98-degree trade square passes, and 7 of the conventional square edge flat passes as shown in the lower part of Figure 20.

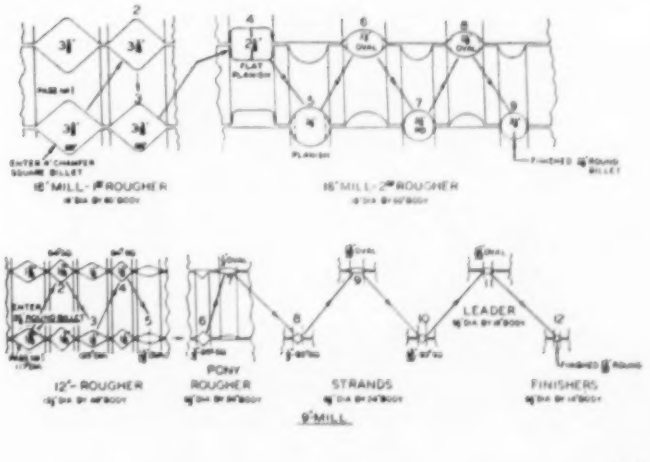
Figure 21 is a flow chart showing the processing of small ingots of tool steel grades made in the 7-ton basic arc furnace and of the carbon and low-alloy steels made in the 25 and 50-ton basic arc furnaces, cast into larger ingot moulds. This chart lists the various operations required to produce the high tungsten steels and high

TABLE V

Heating Time for Billets

Grade of tool steel	Carbon carbon-vanadium, oil-hardening		High carbon, high chromium		High speed steels, hot work, special alloys	
Size of billets, round or square, in.	Heating time in furnace, minutes		Heating time in furnace, minutes		Heating time in furnace, minutes	
	Min	Max	Min	Max	Min	Max
1½	25	30	25	30	40	45
1¾	30	35	30	35	45	55
2	30	40	35	45	50	60
2¼	35	45	40	50	60	70
2½	40	50	45	55	65	80
2¾	45	55	50	60	70	90
3	50	60	55	65	80	95
3¼	55	65	60	70	85	105
3½	55	70	65	80	90	110
3¾	60	75	70	85	100	120
4	65	80	75	90	105	130
4½	75	90	85	100	120	145
5	80	100	95	115	135	165
5½	90	110	105	125	150	180
6	100	120	115	135	165	200

Figure 12 — Chart shows method of rolling tool steel rounds from 4-in. chamfer square to 1¾-in. rounds.



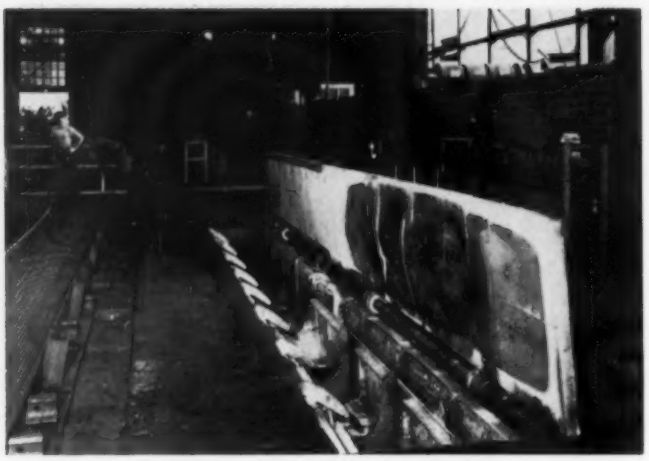


Figure 13 — The holding furnace is heated electrically.

carbon-chromium steels listed as Group No. 1, and the carbon, carbon-vanadium, and low alloy steels listed as Group No. 2.

The one 25-ton and the two 50-ton electric arc furnaces are used in the production of the lower alloy tool steels and the carbon and carbon-vanadium grades. See Figure 22.

Heats from these furnaces are cast in larger ingot moulds than those used for the 7-ton arc furnace. Most commonly used sizes are 16 × 18 in. (5200 lb), 17 × 20 in. (7200 lb), 24 in. and 30 in. corrugated (7800 and 13,000 lb). With the great reduction in cross-section obtained in hot working these large ingots, a grain refinement is attained, equal to that obtained in hot working the smaller ingots from the 7-ton furnace.

After casting, the moulds are sent to the stripping crane where the ingots are stripped and placed vertically in heated, carefully controlled soaking pits (Figure 23). They remain in the pits without firing until the ingot temperature reaches from 1950 to 2300 F, depending upon the composition. The holding time at this temperature range is three to four hours, according to the size of the ingot.

From the soaking pits the uniformly heated ingots are conveyed by a roller line to the 2-high, 35-in. elec-

Figure 14 — Cooling is done at a rate of about 20 F per hr.

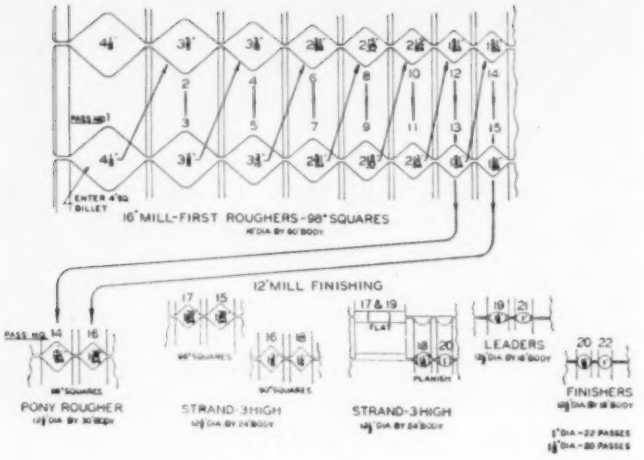


Figure 15 — Chart shows method of rolling tool steel rounds on 16-in. mill and on 12-in. finishing mill, from 4-in. billet to 1⅛-in. round.

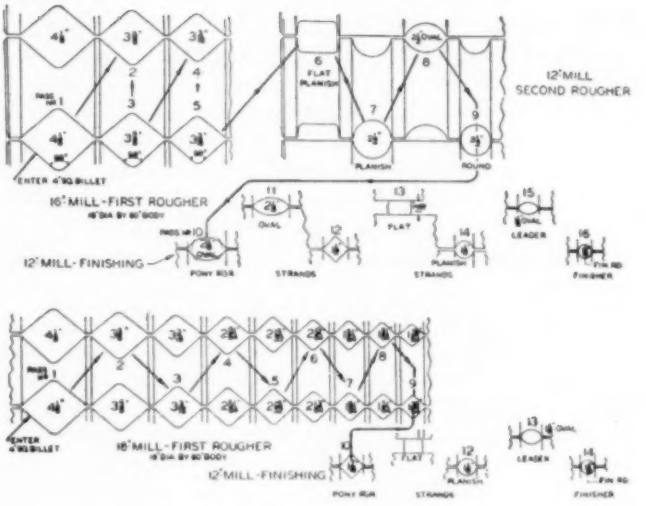
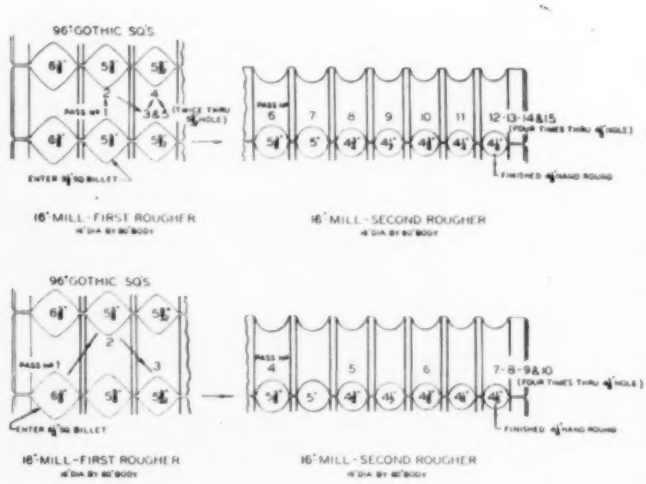


Figure 16 — Chart shows method of rolling 1⅛-in. diam tool steel (above) and alloy steel rounds (below).

Figure 17 — Chart gives method of rolling 4⅛-in. diam tool steel rounds (above) and alloy steel hand rounds (below).



trically driven blooming mill, for rolling into blooms and billets. Some of the grades are double-converted, i.e., the ingots are rolled to the largest cross-section after which they are returned to the soaking pits and again reheated before rolling into the billet sizes. Most of the grades of group 1, carbon and carbon-vanadium steels and group 3, the shock-resistant steels, are rolled directly from ingots to blooms or billets on the 35-in. mill, or,

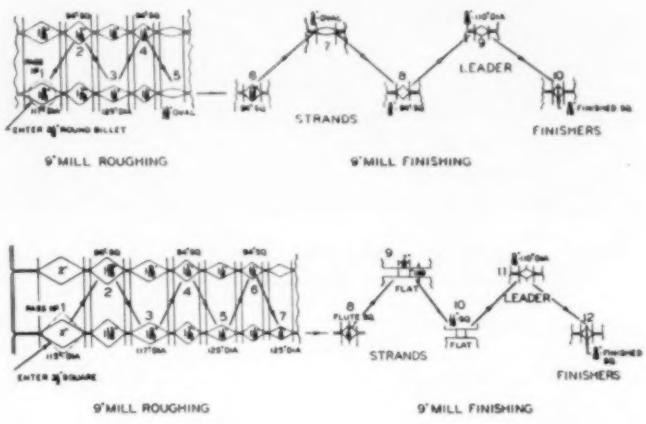


Figure 18 — Chart shows methods of rolling 2⅛ in. round tool steel billets to ⅞-in. finished squares (above), and below rolling of 2⅛-in. square billets to ⅞-in. finished squares.

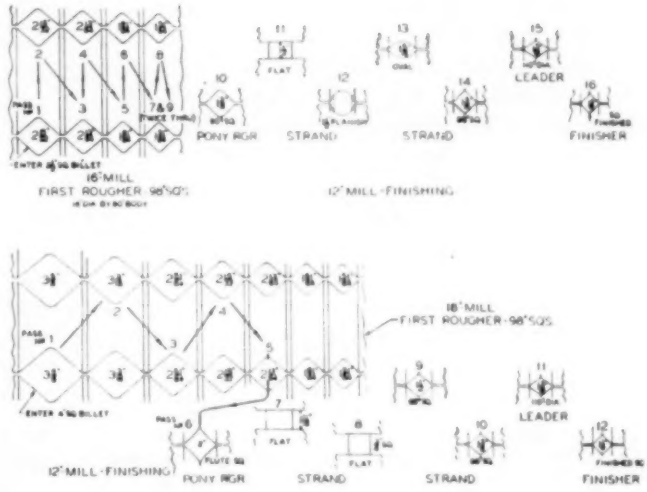


Figure 19 — Chart shows methods of rolling 1⅛-in. sq tool (above) and alloy steels (below).

for the smaller size billets, on the 35-in. mill and 18-in. continuous mill.

The mill delivers the bloom by roller line, Figure 24, to the shear where they are cut to length and either passes on to the 18-in. mill to be re-rolled to smaller size, or placed on the 35-in. mill hot bed. At the shear, the blooms or billets are hot stamped with the heat number, ingot number, and location (top, middle and bottom of ingot). Test pieces are also cut from the top, middle and bottom of the first, middle and last ingots of the heat and the tops of all other ingots in the heat. Discs cut from the sheared test pieces are checked for

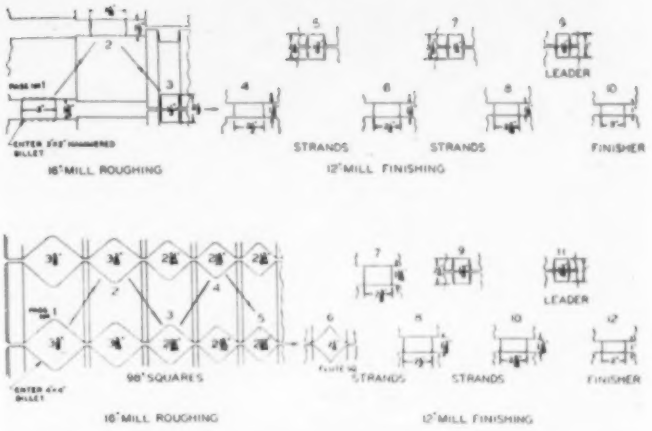
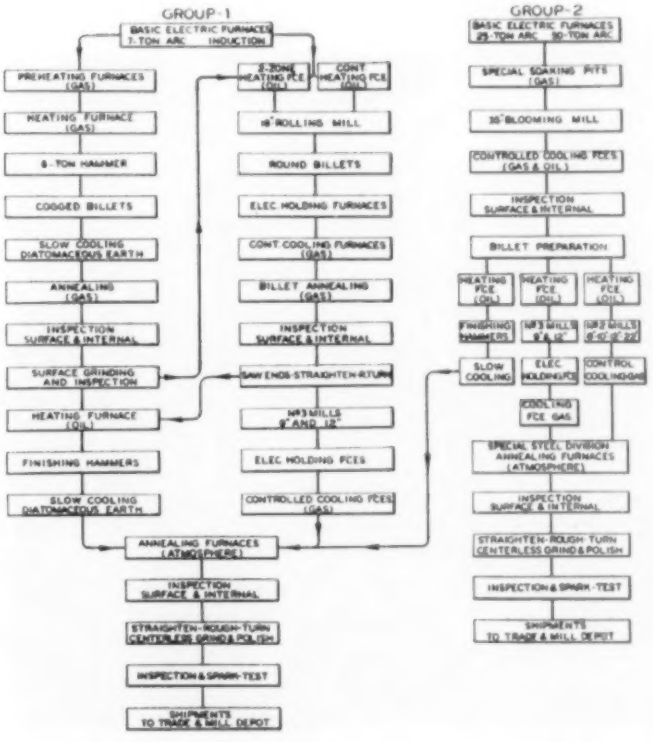


Figure 20 — Chart shows method of rolling 2 in. x 1 in. tool steel (above) and alloy steel square edged flats (below).

chemical composition, grain size, and hardenability, and given a microscopic examination and a hot acid etch for internal soundness. The purpose of these tests is to aid in the manufacturing control and to determine whether the heat of steel is of a satisfactory quality.

The bloom or billets from either the 35-in. mill hot bed and shear or the 18-in. mill shear are placed (Figure 25) in bung-type, gas-fired furnaces equipped with pyrometer control, where they are controlled cooled prior to further surface preparation. They are cut to length, pickled and surface ground. The heat numbers and weights are painted on each bloom or billet, along with other identification required. The carefully prepared billets are then sent to the small rolling mills or hammers for further reduction to the desired finished size. After leaving the mill, the rolled bars are placed

Figure 21 — Chart shows flow chart for processing tool steel.



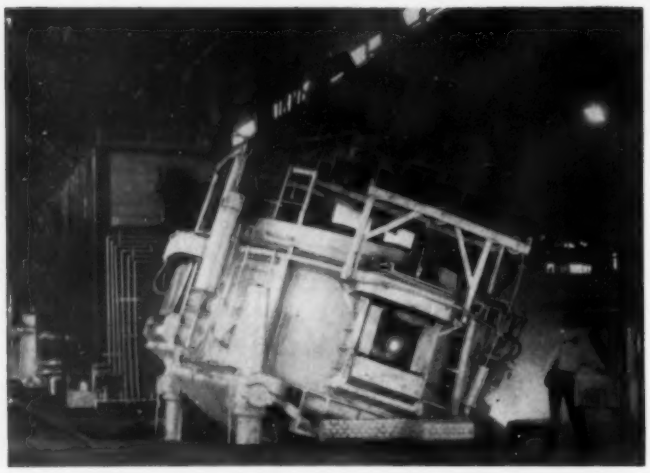
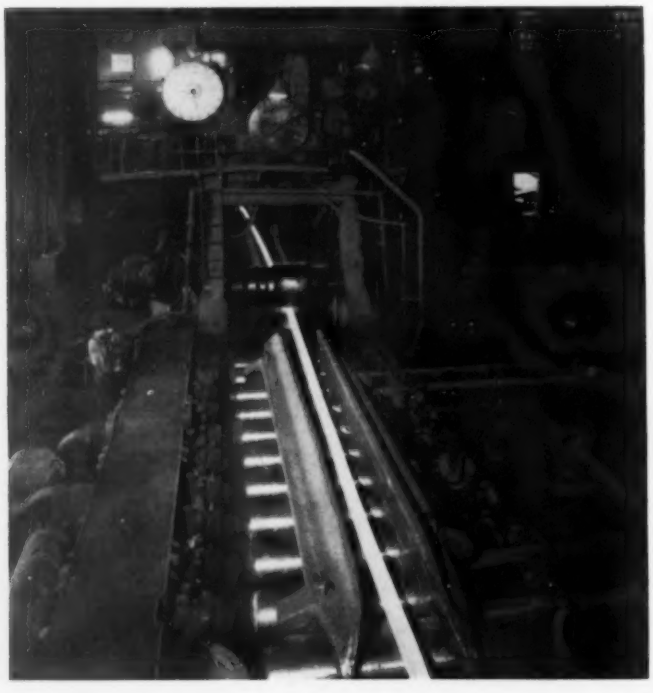


Figure 22 — One 25-ton and two 50-ton electric arc furnaces are used to produce the lower alloy tool steels and the carbon and carbon vanadium grades.

Figure 23 — Ingots are kept in the soaking pit until temperature reaches 1950 to 2300 F.

Figure 24 — The 35-in. mill rolls the larger size billets and acts as a rougher for the smaller sizes.



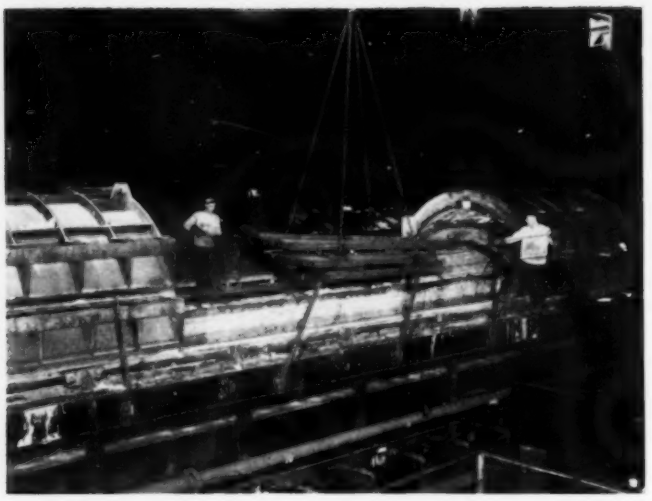


Figure 25 — Steel from the 35-in. mill hot bed are control cooled before further surface preparation.

in holding furnaces prior to controlled cooling or annealing.

Figure 26 shows the new tool steel annealing furnaces, described in the January 1949 Iron and Steel Engineer, in article, entitled "Heating and Treatment of Alloy Steels," by A. H. Arbogast, Engineer of Combustion and K. Morris, Engineer of Combustion, Bethlehem Steel Co., Bethlehem, Pa. The new tool steel annealing furnaces described, use on the average, a mixture of 600 cu ft of nitrogen and 315 cu ft of propane. The fuel rate is 300 lb of bituminous coal per ton of steel, no decarburization occurs, and carburization does not exceed 0.005 in. on a side. The function of the inner cover is to protect the charge from scaling and decarburization. This is accomplished by circulating a controlled atmosphere which is a mixture of nitrogen and propane under the oil sealed inner cover during the annealing cycle.

A typical cycle for a charge of 10,000 pounds of high-speed steel from bell to bell-off is 44 hours, of which 12 hours are required for heating, 6 hours for soaking and 26 hours for cooling. Cooling is controlled to give

Figure 26 — Very good operating results are being obtained with the new tool steel annealing furnace.

temperature drop of 30 F per hour down to 900 F, as registered by base couples. During the heating cycle, when the base couples reach 950 F, the inner cover is purged with 300 cfhr of nitrogen until the oxygen content has dropped below 3 per cent. The flow is then reduced to 240 cfhr and propane is introduced at the rate of 20 cfhr. The flow reversal cycle is set for 15 minute periods.

After the introduction of propane, the reduction cycle requires a more careful control of the CO_2-CO ratio until a maximum of 1 part of CO_2 and 3 parts of CO has been reached. At this point the flow of nitrogen is cut to 100 cfhr and the propane to 3 cfhr, the inner cover pressure is raised to 1 in. water. An effort is made to maintain a ratio of 1:3 for the balance of the heat.

When the cooling cycle has reached 1050 F, the propane is shut off and the inner cover is purged with nitrogen until the base couples have dropped to 980 F. At 900 F the outer cover is removed and placed on another base for the start of a new heat, while the inner cover remains in place until the base couples drop below 300 F.

On the average heat 6000 cu ft of nitrogen and 315 cu ft of propane are consumed. The metallurgical atmosphere had responded well to requirements. The residual oxygen carried by the nitrogen has never prevented the successful establishment of proper carbon balances by addition of propane.

On the whole, the results obtained from this newly developed furnace system have been very gratifying. To date there have been no difficulties due to the surface decarburization, although we have experienced some slight carburization. These effects, however, are the result of operating conditions and should be followed and corrected from heat to heat by proper manipulation of temperatures, pressures and atmosphere flows.

The annealed bars are tested for hardness, decarburized surface, internal soundness (hot acid-etch tests) and are given a fracture test and microscopic examination. Bars that have satisfactorily passed inspection are further processed by machine straightening and rough turning or centerless grinding, or cold drawing where required. They are also given a final spark test. Careful inspection through all operations is necessary to insure against defects in the finished material and to produce a uniform and high quality material.

DISCUSSION

PRESENTED BY

C. P. HAMMOND, Superintendent of Mills, Rotary Electric Steel Co., Detroit, Mich.

J. P. BEAL, JR., Universal Cyclops Steel Co., Titusville, Pa.

H. C. BIGGE, Superintendent of Tool Steel Division, Bethlehem Steel Co., Bethlehem, Pa.

JOHN R. HARBAUGH, Jessop Steel Co., Washington, Pa.

C. P. Hammond: No doubt, you noted that the high speed and the higher alloy steels were hammer cogged from ingots to billets. There are some companies that have been very successful in roll-cogging high speed steel, not for the larger sizes or sections, but, possibly by using approximately a seven inch square ingot to produce rounds or sections, with an area of approximately one and one-half inch round.

Different proceedures are followed in some plants, ingots are charged hot and others slow cooled and then reheated and hammered or rolled. This paper presented by Mr. Bigge should be of great value to the tool steel manufacturers.

J. P. Beal, Jr.: May I ask Mr. Bigge what progress has been made, or what the possibilities are of using atmosphere controlled gas fired annealing furnaces to recarburize bars which have become decarburized due to excessive holding times in the rolling mill furnaces. Is it possible to salvage this type of material by increasing the carbon potential of the gas in the annealing furnace?

H. C. Bigge: It is possible to carburize material by increasing the carbon content of the reducing gas. However, we do not advocate this practice as the majority of the customers' specifications for rolled and annealed bar stock does not permit it. If we encounter any difficulty on account of excessive decarburization, the material is salvaged by grinding it to a smaller diameter.

John R. Harbaugh: As I listened to the paper, the author stated that the seven-ton arc furnace produced the high speed steels and high alloy content tool steels and these grades are cast into sizes from 9-16 in. square ingots, is that correct?

H. C. Bigge: That is correct.

John R. Harbaugh: I would like to have some expression of the success in reducing 16-in. square high speed steel ingots of the 18-4-1 composition.

H. C. Bigge: The 16-in. square ingots of 18-4-1 composition are cast into 16 × 16 × 47 in. body length cast iron molds with 7½ in. diameter cast iron plug. The mold measures 16 in. square at the top and 14 in. square at the bottom, with 3½ in. wall thickness at the top. We use a brick hot top which is preheated to 1400 F and placed on the mold and the space between the inside of the mold and outside of the hot top is

TABLE VI

Mold size	16 in. Sq.	13 in. Sq.
Type bottom	Cast iron plug	Copper stool
Top dimension		
Inside, in.	16	13
Outside, in.	22¼	18
Wall thickness, in.	3⅛	2½
Bottom dimension		
Inside, in.	14	11⅜
Outside, in.	24¼	20¾
Wall thickness, in.	5⅛	4⅜
Body length, in.	39	32½
Bottom, length, in.	8	6
Total length, in.	47	38½
Taper per side, in. per foot	0.2552	0.2534

packed with asbestos rope. Total weight of an 18-4-1 ingot is 3200 lb.

We have conducted many experiments with various sizes of molds and various wall thickness to determine the most favorable condition and cooling rate of the metal, to obtain the best carbide distribution in the larger size ingots. In these experiments, we drilled a 3/8-in. hole, 6 in. deep, at the top of the mold, midway between the outer and inner surface. In this hole we placed a platinum: platinum-rhodium thermocouple and packed and sealed it to exclude any air. The immersion couple was attached to an electronic recorder. We have found from these experiments that it is possible to strip the 16-in. ingots within 1 hour. The ingots are charged hot into the preheating furnace held at 1400 to 1420 F. After charging, the ingots are held for about one hour, to equalize their temperature. They are then heated to 1410 to 1430 F, held at this temperature for 5 hours, cooled in the furnace at a rate of 40 to 50 F per hour, to 1000 F, held at 1000 F for 3 hours, air cooled to room temperature. After air cooling they are reheated to 1650 F and transferred to the heating furnace for heating for forging.

Additional experiments were made recently with 16 and 13 in. square ingots of high speed steel of the 18-4-1 type, teemed into cast iron molds of the dimensions in Table VI.

The 13-in. square ingot showed a better carbide distribution than the 16-in. square ingot. However, the smaller ingots necessitate shipping shorter length bars.

IRON-ORE BENEFICIATION — PRESENT PRACTICES AND TRENDS*

▲ BENEFICIATION of iron ores refers to any treatment of the ore whereby a more acceptable product for use in the blast furnaces is produced. Included in the field of beneficiation are all the diverse processes that are designed to improve the ore chemistry, the ore structure, or both. Usually both structural and chemical improvements are sought.

The types of ores, from a beneficiation viewpoint, can be broadly grouped as follows: (1) merchantable ores, (2) wash ores, (3) intermediate ores, (4) taconite.

It would appear more probable that magnetic roasting will be used, rather than flotation, for the nonmagnetic taconites because:

1. Natural gas for fuel is to be available on the Mesabi Range by 1953. This would materially reduce the cost of roasting.

2. By magnetic separation, a tailing could be rejected at a coarse size, so that it would be unnecessary to grind all the taconite to the ultimate mineral liberation size. This would mean a saving in grinding costs. This could not be done with flotation methods.

3. For a given tonnage, flotation methods would require a greater supply of water.

4. Power consumption by present flotation methods would probably be greater than by roasting and magnetic separation.

5. Magnetic separation is a simpler, cheaper, and more positive concentration process than the flotation processes.

As the intermediate ores treated become those closer to true taconites, the structure of the concentrates produced becomes finer. When taconites are finally treated, the concentrates, of course, will all be minus 100-mesh. If this material is to be smelted in a blast furnace, it must be agglomerated in some manner to prevent it from being blown out of the furnace. Various methods of agglomeration have been proposed and tested, such as: briquetting, pelletizing, sintering, and nodulizing. All of these methods have certain limitations and objectionable features.

Metallurgically, the concentration procedures are relatively simple and quite well worked out. The agglomeration procedures are still the stumbling block and much research remains to be done along these lines. Finely divided materials are easier to reduce than coarse chunks, therefore it would seem reasonable to take advantage of the concentrate structure and try to adapt a process to the ore rather than to try to remodel the ore to fit an established process. For a parallel, consider the copper industry, where blast furnaces were used exclusively for smelting when the ores available were coarse but, as fine concentrates from flotation became the only available charge material, the blast furnaces were abandoned and smelting is now carried out in reverberatory furnaces. Why should not more thought be given to other methods of smelting the fine iron-ore concentrates rather than to directing all the effort to development of agglomeration methods?

Two other problems in connection with the establishment of a taconite industry in Minnesota have received inadequate public consideration. The quantities of electric power and of water necessary to produce a large tonnage of concentrates from taconite are very large. Serious thought must be given to the question of where the water and power, particularly the latter, can be obtained in adequate quantities.

* Abstracted from paper of same title presented by Stephen E. Erickson, M. A. Hanna Co., Hibbing, Minn., at AIMME Blast Furnace, Coke Oven and Raw Materials Conference, April 3, 1951 at Cleveland, Ohio.

Centerless Turning of Bars, Billets and Tubes

By WALTER SIEGERIST
President
The Medart Co.
St. Louis, Mo.

. . . . today's modern centerless turners and peelers have been designed to utilize fully the best cutting tools developed to date . . . .

▲ THE centerless turning and peeling of bars, billets, and tubes consists of the operations necessary to remove the surface of a bar or tube to a desired depth. The depth or thickness removed from the surface determines whether the operation is turning or peeling. A heavy, deep cut is generally referred to as peeling. Hence, billets are always peeled. Bars are turned for several objectives, such as to remove the surface in preparation for the next operation — for example, centerless grinding, or producing turned and polished shafting, or simply to remove that portion of the surface that has become decarbonized or has lost some of the alloy content. One of the commonest examples of surface preparation by turning is the turning of SAE 52100 seamless tubes in preparation for producing antifriction bearing races.

The term "centerless turning" is used in a sense similar to "centerless grinding," but these operations are not exactly similar. Both processes eliminate the mounting of the workpiece between centers as in a lathe. The workpiece rotates in centerless grinding as it moves past the rotating cutting wheel, but in centerless turning the workpiece definitely does not rotate as it moves past the rotating cutting tools. The original objective, when centerless bar turning was first used more than sixty years ago, was to produce truly round shafting from iron and steel bars that were only approximately round and also only approximately straight. This still remains as the prime objective, but the machines used today have changed tremendously.

Figure 1 shows one of the later models of the self-feeding type of centerless bar turners. The machine consists of three essential parts. The input section consists of a pair of round bars forming a runway on which a carriage carrying a hand operated gripping vise runs back and forth. The vise grips the bar and absorbs the

Figure 1 — Self-feeding centerless bar turner.

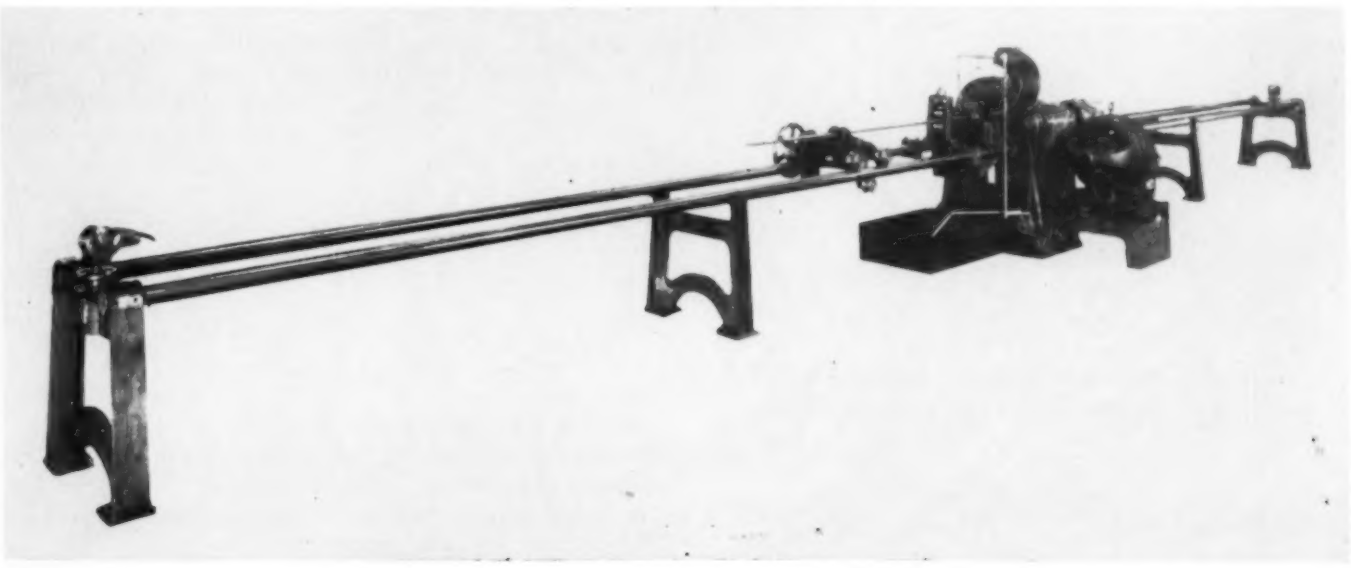
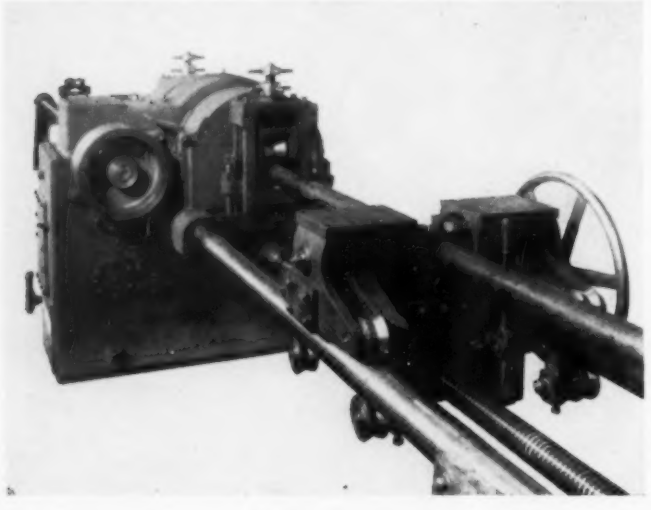


Figure 2 — The cutter head consists of eight thread chasers which have a triple thread.

cutting torque. The second part is a cutting section which carries one cutterhead driven by the driving motor, and the third part the output section which is a duplicate of the input section.

The operation of this type can be understood by examining Figure 2. This is the cutterhead viewed from the output side. It is an assembly of eight thread chasers having a triple thread. These are arranged in two sets of four each, and are in turn surmounted by one set of four cutting tools. Thus the operator, after gripping the bar in the input vise, pushes the end of it into the first set of rotating threading dies. These dies feed the bar into the next set and then the two sets thread the bar through the four cutting tools which remove all the threads plus a slight amount under them. Thus the out-of-roundness does not influence the finishing tools and, likewise, the bars could be bowed or crooked without affecting the accuracy, because the threading dies center the workpiece immediately ahead of the

Figure 3 — The lead screw was a valuable addition to the self-feeding cutter head turner.



finishing tools. The shortcomings of this machine, however, are obvious. It is slow. (An average production of 18 to 20 inches of bar per minute is the best obtainable.) A very serious drawback is the fact that the depth of cut is limited to the shearing strength of the threads and, worst of all, this type of machine can handle only material that can be easily threaded.

The next development is shown in Figure 3. This is an improvement over the self-feeding cutterhead type because a lead screw has been added, thereby transforming the grip carriages into feeding mechanism as well as taking the tool torque. The threading tools were dropped out of the cutterhead, and guide blocks of cast iron substituted. A cutterhead is mounted on both ends of the hollow spindle so that the input head can take the roughing cut and the output head the finishing cut. This machine is much faster than the self-feeding type. It approached the ideal of turning as fast as the tool steels will permit, with the exception that the long bar length from the grip jaws to the cutterhead permitted too much twist in the smaller diameter bars and particularly in the turning of tubes. The worst feature was the awkward loading and unloading characteristics.

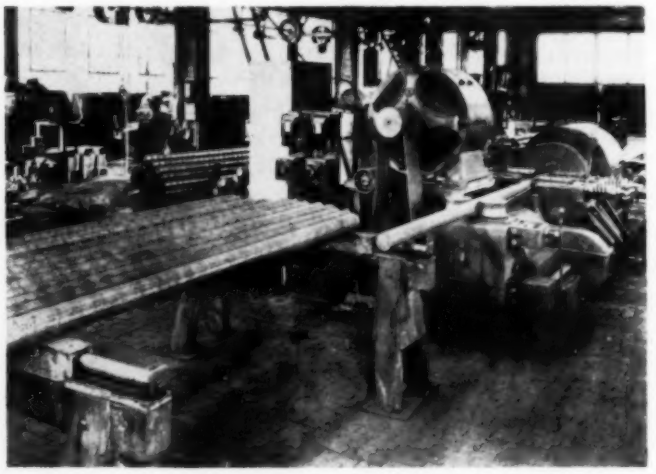


Figure 4 — Grip feed type centerless bar turner.

This design illustrates very effectively the fact that to get maximum production out of the cutting section of a machine, the loading and unloading time must be reduced to zero, and the manual effort required of the operator should also be reduced to zero if possible.

The next big step forward is the machine brought out by the Messrs. Brightman known as the grip feed type. Figure 4 shows one of these in an eastern alloy steel plant. The bar or tube is fed into the cutterhead by a pair of reciprocating cam actuated grip jaws that are spring loaded by another set of cams so they also absorb the cutting tool torque. Figure 5 shows these grip jaws very clearly and also the two cutterheads that are mounted in a trunnion that is driven by a roller chain.

The grip jaws are reciprocated by a roller engaged in a double faced cylinder cam. The timing is so arranged that there is an overlapping of the forward strokes, thereby insuring uninterrupted forward feeding of the workpiece. The overlapping of the forward or feeding strokes permits the number one jaw to hold the bar while the number two jaw is gripping and also moving forward on the feeding stroke. The number one jaw

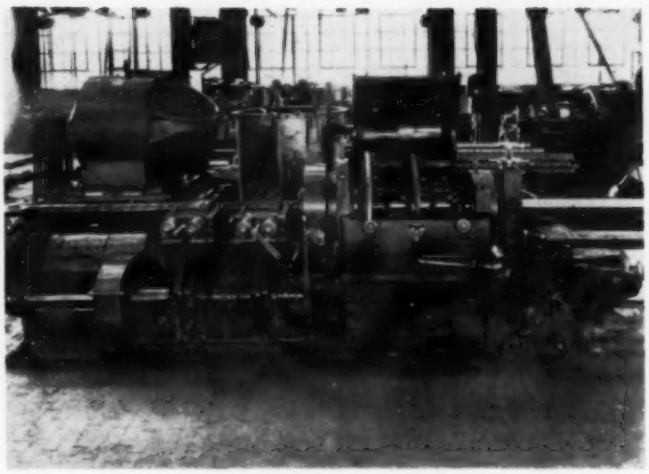


Figure 5 — The cutter heads are mounted in a trunnion which is driven by a roller chain.

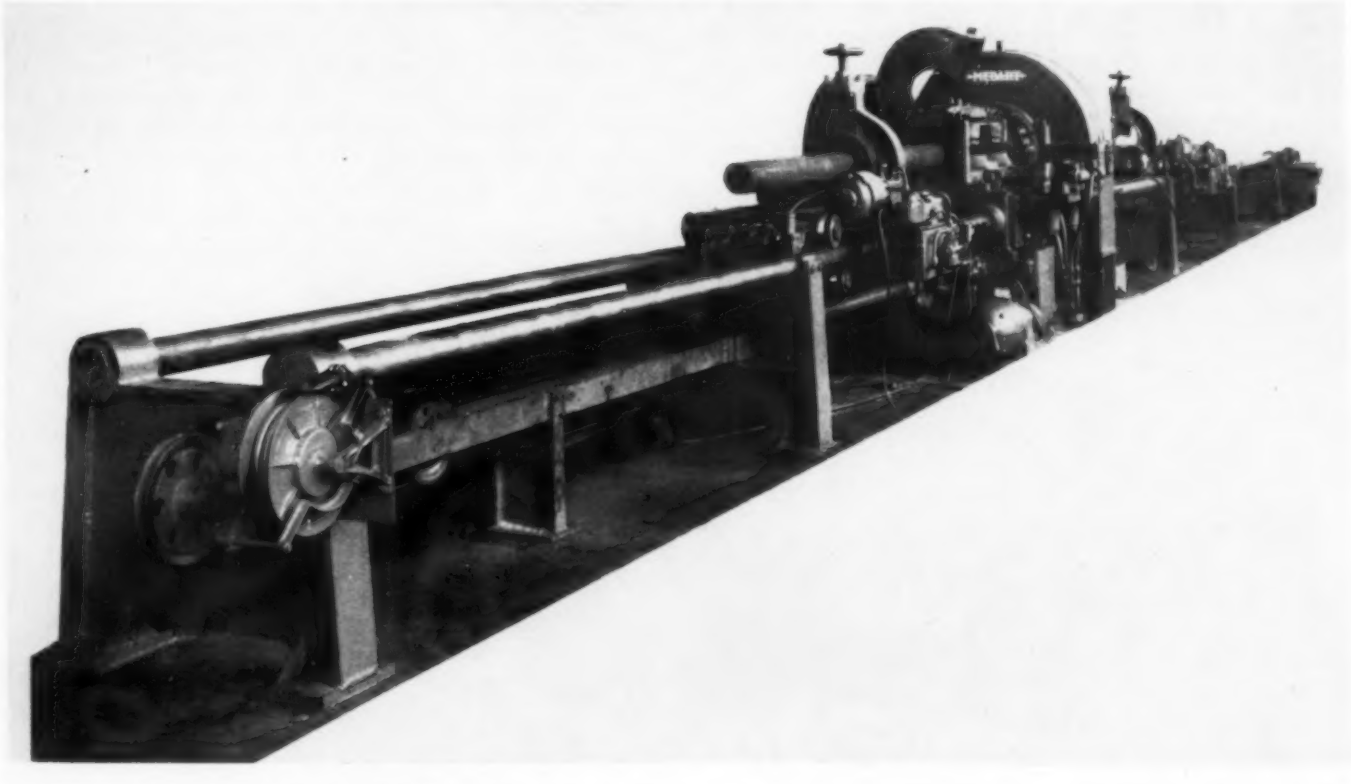
then is released after the number two takes over. Then number one returns to the starting position and again overlaps on the forward stroke and takes over so that number two can return, and so on. This is the first type of centerless turner that was specifically designed for uninterrupted end-to-end feeding so as to reduce the loading and unloading time in the cycle to zero. This machine is the first one that would out produce the high speed tool steels when it was brought out. However, it still has the disadvantage of a rather long span between the grip jaws and the cutterheads. It also is a long bar machine because of the arrangement of the parts — that is to say, the minimum bar length it will handle is about 12 ft. Another characteristic that is objectionable, according to present day standards, is the feed rate variation because of the transfer of the forward thrust load from one grip to the other one. This produces a bar surface variation spaced at the distance of the grip strokes. These variations in surface could always be polished out in our two-roll straightening, sizing and polishing machine. However, this surface characteristic soon became objectionable to the trade using unpolished Brightmanized bars and particularly tubes.

The higher standards required by the trade and the improvement in tool steels led to the design of the roll feed hydraulic grip type of machine, shown in Figure 6 and Figure 7. Here we again have the separation of the gripping and feeding function. There is a hydraulically actuated short run input grip carriage, four automatic centering feed rolls, the input and output cutterheads, and a hydraulically actuated output grip automatic return carriage.

The bar or tube is rolled into the input grip carriage from a stock table. All the operator does is push the starting actuating button. This sets the grip, moves the bar forward until the end butts against the end of the preceding bar that is being turned, thereby reducing the loading time requirements to zero, because the bars go through the machine end to end. The loading and unloading is all done while the machine is turning a bar.

Figure 7 shows that each feed roll, in this type machine, is individually loaded by its own hydraulic cylinder. Each pair of rolls is tied into an automatic centering device arranged above the rolls. This automatically compensates for the diameter variations in hot rolled bars and tubes. This automatic centering device produces a uniform chip load, thereby promoting accuracy in size and, of greater importance in tubing, it does not change the tube eccentricity. This is of special importance when heavy wall tubing is turned because this tubing has considerable diameter variation in the "as rolled" condition. The feed rolls are driven by a separate motor so that there is maximum flexi-

Figure 6 — Roll feed hydraulic grip type centerless bar turning machine.



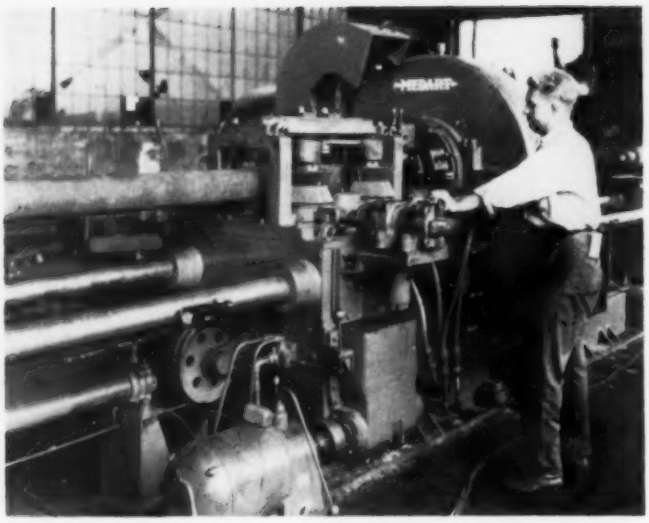


Figure 7 — Each feed roll is individually loaded by its own hydraulic cylinder.

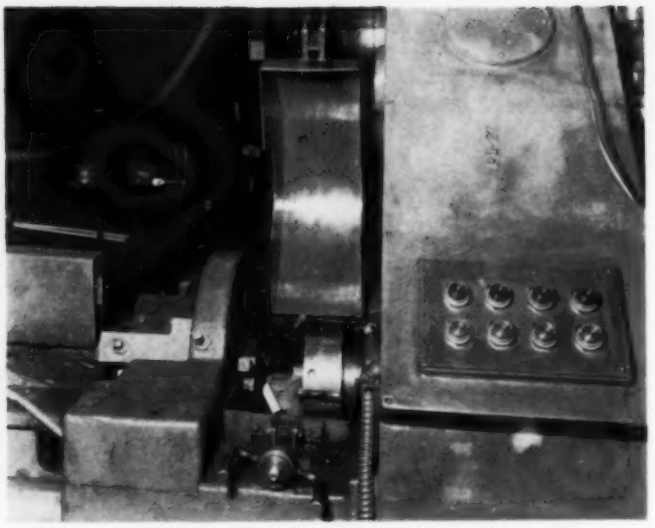


Figure 9 — The three torque chippers center the bar as they groove it.

bility between the choice of throughput feeding rates and tool tip speeds. The feeding rate range furnished on standard machines is generally from 1 to 12 fpm throughput.

The question asked by the people interested in buying centerless bar turners is: "How many feet of bar will I get per minute?" The answer depends on many factors, but the writer has one answer that is always true for all the latest model machines: namely, "You can get as many feet per minute as your cutting tools will stand. The machine is built for better tools than you can get today." This is a fact. Table I, for example, shows the tool tip speeds available for the bar diameter range when the machine is belted with a 10-in. pitch diameter motor V-sheave wheel and a 25-in. on the machine.

The maximum feeding rate is dictated by the finish required, as well as the material being turned. Some difficult alloys may not permit more than 8 in. per min feed rate, whereas a free turning steel can be put through at 6 fpm with an excellent surface. The tool tip speed may vary from 50 to 100 fpm. These machines all use a wide face tool of about 2 in. or more width. This is high torque turning. All of the above statements apply to high speed steel tools turning bars of 1¼ in. to 10 in. diameters or larger.

CARBIDE CENTERLESS TURNING

About four years ago a demand for smaller bar diameter turning in the range from ⅜ to 2 in. developed, particularly in Europe and India. In the foreign countries the requirements seem to fall in the range from ⅜ to 1 in. diameter. The high torque, heavy chip characteristic of the high speed steels, together with the necessity for rigidly holding the work-piece adjacent to the cutting tools, prompted the writer to develop an entirely new centerless turner exclusively for the use of carbide turning tools. This is a high tool tip speed, light chipload machine, known as the push draw type shown in Figure 8. Here again is the familiar pattern of four automatically centering input rolls, but beyond that point things are different. A torque chipper has been introduced just ahead of the rotating cutterheads. There is only one cutterhead with a minimum of three tools. Figure 9 shows the three torque chippers and the cutterhead. The three torque chippers are three very wide

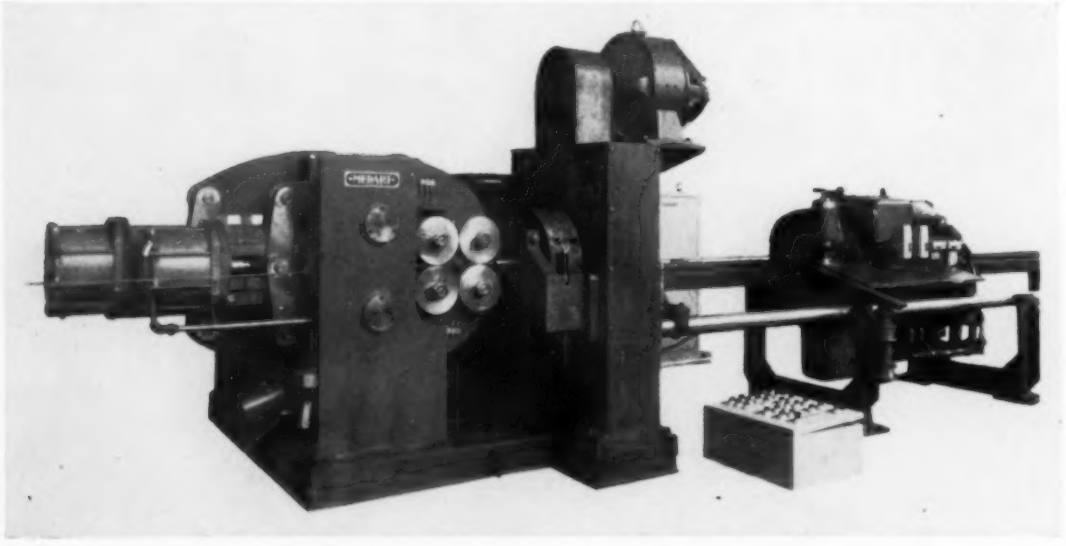


Figure 8 — Push draw type carbide tool centerless turner.

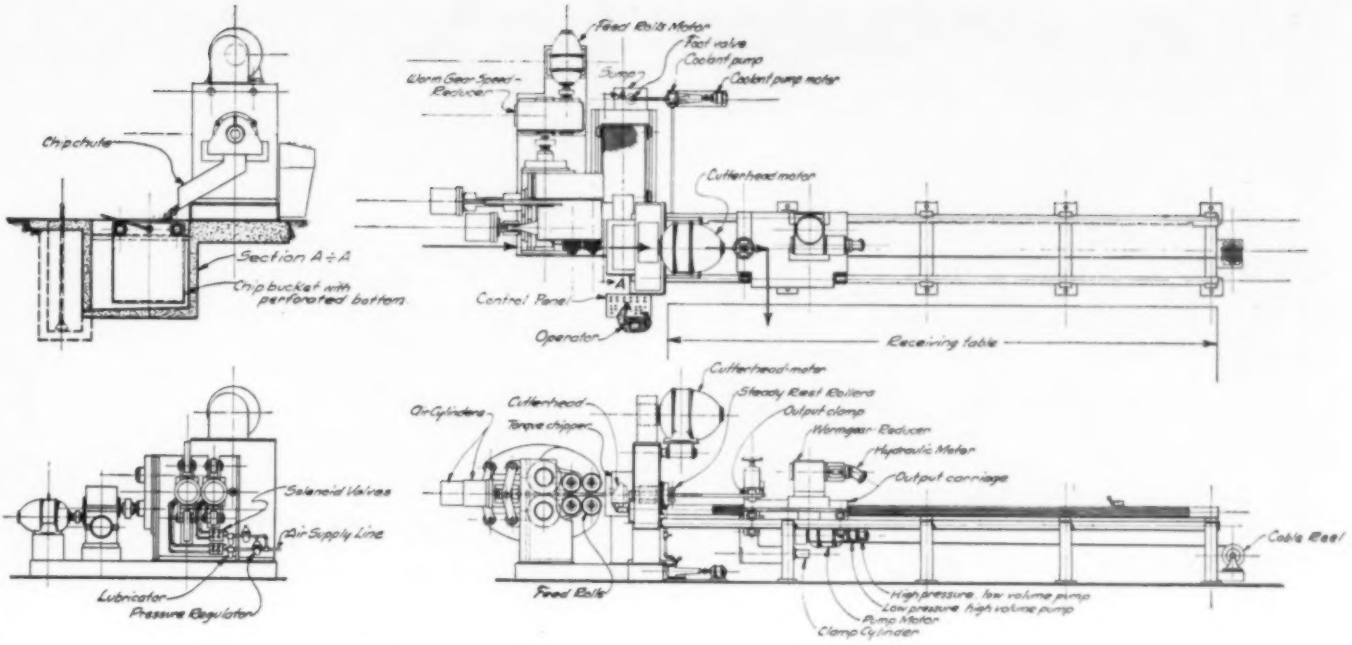


Figure 10 — Detail of push draw turner with carbide tools.

faced tools, somewhat like sled runners. They are ground to a "V" with the edge parallel to the axis of the bar. They center the bar as they groove it. The grooves furnish the torque absorbing shoulders and also insure chip breakage. This is a necessity in carbide tool centerless bar turning, particularly for certain types of steel.

The bar is thus supported within ½ to ¾ in. of the cutting tools. This furnishes the rigidity so necessary for carbide turning. This machine, therefore, has a rigid holding and centering device ahead of the tools instead of only a circle of rotating centering guides following the tools as is the case in machines primarily designed for bar diameters over one inch. There are guides following the carbide tools but they function only for the last ½ or ¾ in. of bar. The bar is pushed through the machine by the feed rolls until it extends between the output grip carriage jaws. This carriage is propelled by a hydraulic motor which drives a pinion engaged in the gear rack shown on one of the runner bars in Figure 8. The carriage starts forward, at a speed faster than the bar feed, before the grip on the carriage is set. Then the grip sets, thereby causing the carriage to set up a tension in the bar. This sequence is either manual or automatic. In this machine ¼-in. bars have been turned down to $\frac{13}{64}$ in. diam.

The feed and cutterhead drives are individually motor driven. The tool tip speed can be varied from 150 to 600 fpm in the mean diameter of the machine range. The feeding rate is largely dependent upon the type of surface required and also what diameter tolerance is desired. The feeding rate for most materials is from 4 to 10 fpm. Runs of 12 fpm throughput are often made. These machines will handle anything that can be cut with carbide tools. The diameter reductions generally range from 1/16 to ¼ in. The heavier cuts are required for removing the surface decarb.

TABLE I

Tool Tip Speeds for No. 10 Centerless Bar Turner

Motor Speed rpm	Cutterhead speed rpm	Tool tip speed — Surface fpm			
		3-in. OD bar	5-in. OD bar	7-in. OD bar	9-in. OD bar
400	26.5	21	35	49	62
600	40.0	31	52	73	94
800	53.3	42	70	98	126
1000	66.6	52	87	122	157
1200	80.0	62	105	147	188

Cutterhead gear ratio 6 to 1
V-belt sheave ratio 2.5 to 1

DIAMETER TOLERANCE

The modern high speed steel and carbide type of centerless turning machines are both extremely accurate. The high speed steel turners will hold a total tolerance of 0.005 in. with ease. A careful operator, and the use of a two-roll sizer and polisher, will produce turned and polished shafting within a tolerance of 0.002. A Swiss steel mill regularly produces turned and polished shafting to a tolerance of 0.001. This, however, requires additional passes in the polishing machine and continuous gaging at the turner.

The turner, with carbide tools, when set to correct diameter will hold this diameter until the tools are dull. The run generally is about four to six hours, again depending on the tolerance requirements. The high speed steel tools require occasional resetting of the guide blocks, but generally run longer than the carbide tools (usually for one shift of 8 hours). There have been runs of over 100 hours per grind with sulphured cutting oil as the coolant. A typical turner arrangement is shown in Figure 10.

Perhaps it is in order at this point to discuss the preparation of the bars to get them ready for turning. The roll feed type of machines using high speed steel cutters obviously will handle the bars without diffi-

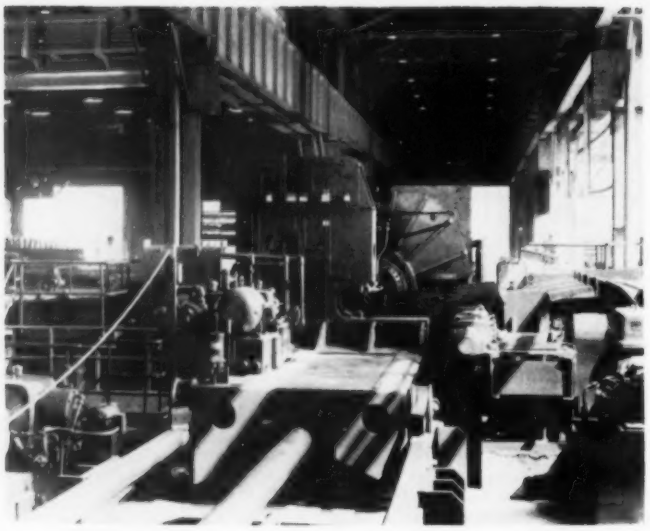


Figure 11 — Hydraulic billet peeler.

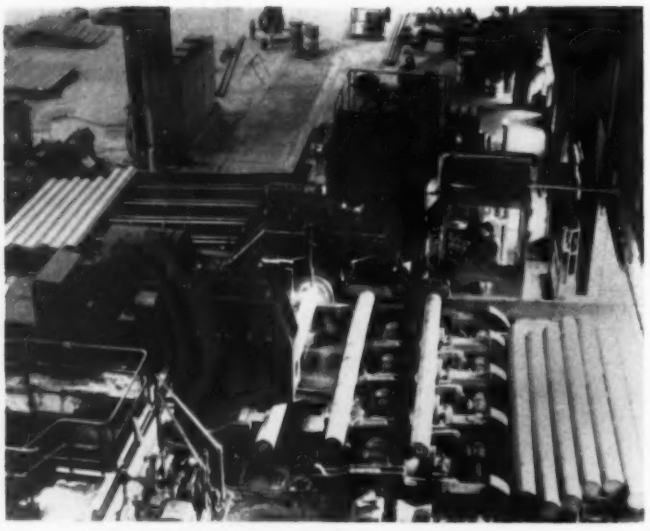
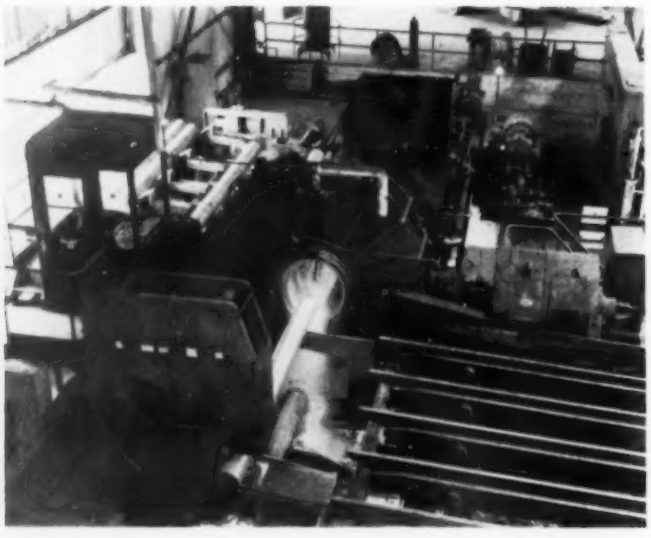


Figure 12 — Many of the operations on the billet peeler are automatic.

Figure 13 — Total installed horsepower on this billet peeler is 555.



culty, even though they are cambered or have long radius bends. Diameter variations, due to rolling mill practice, also does not bother in any way. However the remarks regarding the ability to handle crooked bars apply only if the diameter variation tolerance is liberal. It can be readily understood that when the bar pushes up for a length of 6 feet, then to one side for the next 8 feet, and again to the opposite side for 10 feet, and then floats the remaining 18 feet, that there may be a few thousandths variation in the first 22 feet as compared to the 18 feet that were really straight. The out-of-roundness also influences the accuracy, particularly when close tolerances are required. Fortunately, all bars and tubes can be ideally prepared for centerless turning, and also centerless grinding, by putting them through a two-roll straightening and sizing machine. This will straighten them absolutely dead straight from end to end, crack off the mill scale and correct out-of-roundness. This operation is referred to, in cold finishing plants, as rough bar straightening and rounding. Some shops even pickle the bars before turning because this gives slightly better accuracy and longer tool life. It is decidedly worth while in some instances. The bars must be rotary machine straightened from end to end for carbide tool turning.

COOLANTS

All turners using high speed steel cutters must be operated with tool coolants. The choice depends upon the nature of the material being cut, the type of tools, and so on. Generally speaking, an all oil coolant will produce a higher finish, whereas a water soluble oil mixture coolant is more desirable for heavy cuts where heat removal is of special importance.

Whether to use or not to use coolants with carbide tools in centerless turning is a question on which both sides have the same number of advocates. Thus far, the operators of centerless turners in the United States use coolants, whereas the operators in foreign countries do not use coolants. A direct comparison of results is possible between the United States and Swiss practice. Both plants have identical turners — the American plant turns wet whereas the Swiss plant turns dry. The results, as to tool life and accuracy, are identical in both plants but the Swiss plant is not required to bother with the coolant. Both plants hold to the same tolerance, and both find that this is maintained for about four hours when the tools become dull and require regrinding.

BAR PEELING

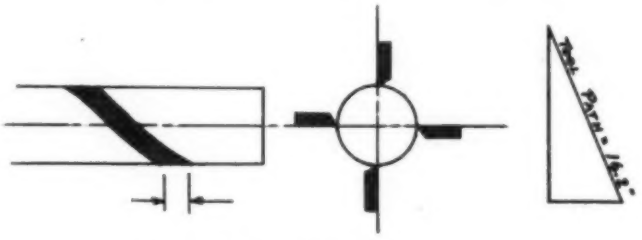
Unlike bar turning, bar peeling does not involve accuracy as to diameter and generally the surface condition is what most machine shops would consider very rough. The object is to get the surface off as fast as possible. Some billet peeling is done with the roll feed, high speed steel machines shown in Figures 6 and 7. However, forged and some rolled billets are much larger than can be handled by the roll feed method. Such jobs require the "HBP" type billet peelers shown in Figures 11, 12 and 13. The "H" means hydraulic and "BP" means billet peeler. This machine has a range from 3¼ to 13-in. diameter billets, varying from 7 ft

to 16 ft, normally, or any length that can be brought into the building as a maximum.

The machine again consists of the same three essential parts: an input grip and feed carriage, a cutting section, and an output grip and feed carriage. All gripping and feeding is done hydraulically. The cutterhead is equipped with tools having a face width of 2 to 2½ in. depending upon the billet diameter. There are never less than four tools. The number is increased generally by one more tool for each 2 in. diam increase over 6 in. for maximum tonnage results. The cutting tool paths overlap only at the edges. Therefore, each tool cuts its own helix on the bar surface. The machine capacity is accordingly calculated as given in Figure 14. The depth of cut always exceeds one-eighth inch reduction of diameter.

The horsepower required to do the job is in keeping with its size. The cutterhead driving motor is a 300/900 rpm, d-c 300-hp motor. Each grip jaw has a 15-hp motor. Each hydraulic feeding cylinder has a 100-hp motor. There are coolant, oil and other auxiliary motors amounting to 25 hp. The total horsepower, therefore, is 555 hp. This does not include auxiliary equipment, such as chip conveyors, car loaders and so on that are required to remove the chips produced in the peeling

Billet size, in.	Cut width per tool, in.	No. of tools	Feed rate, fpm	Cutter rpm	Tons per hour	Tool tip, speed fpm
3¼	1	4	40	120	33	102
4¾	1½	4	40	80	50	108
6	1½	4	20	51	50	81



4 Tools cut a net width of 6 in.
Feed rate = 40 fpm

$$\text{Cutterhead rpm} = \frac{40 \times 12}{6} = 80 \text{ rpm}$$

$$\text{Tool tip speed} = \frac{80 \times 16.2}{12} = 108 \text{ fpm}$$

300-hp motor, 300/900-rpm direct connected
Cutterhead range of 40 to 120 rpm

Figure 14 — Machine capacity is given by this table and diagram.

operation. The overall dimensions of a typical large billet peeler are shown in Figure 15.

The operation of a billet peeler can be understood by studying Figure 12. This is a bird's-eye view taken from the input end. The stock of billets (8 in. diam × 9 ft long) is brought to the inclined stocking table by crane

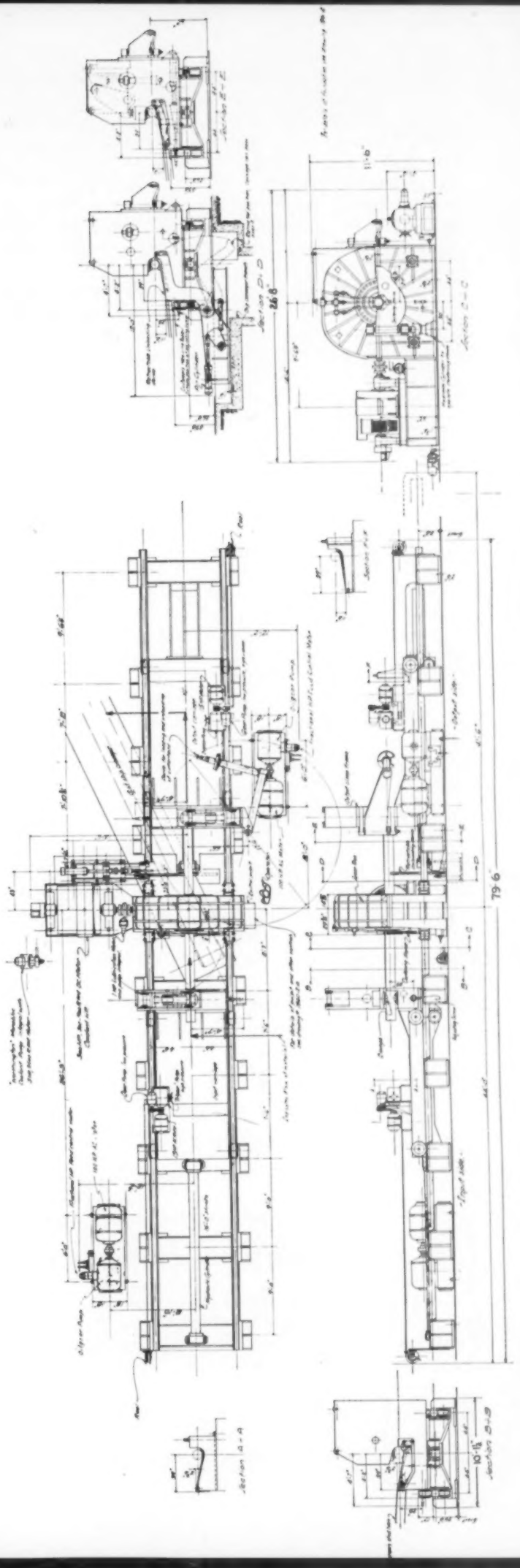


Figure 15 — Detail drawing of typical large billet peeler is shown in right hand column.

delivery. The flippers perform the lifting function of lifting one billet onto the positioning rolls, moving one on the rolls forward and at the same time depositing one billet in the jaws of the input grip carriage. The operator shown in the glass enclosed pulpit controls all operations. Pushing one button will load a billet. A second button centers the billet at the entering end and sets the grip jaws. A third button sets the feeding into operation. The billet now moves through the cutterhead.

The billet on the output side has been automatically discharged and the output carriage has been brought back to the starting position awaiting the end of the billet. The end of the billet automatically starts the output grip carriage and sets the grips. An automatic control releases the input grips and reverses the input carriage to bring it to the starting position. This completes one cycle. This operation is repeated for each billet. All hydraulically operated functions can be individually controlled by the operator if required. The motors are interlocked for safety so that the cutterhead must be in rotation before the feeding and gripping motors will run. The lubricating oil pressure is interlocked with the main motor control so that low oil pressure automatically shuts down the entire machine.

A billet peeler of this size requires many special features, such as radial and axial thrust bearings for the cutterhead trunnion that will take the full load of the 8-in. diam cylinders pushing forward at 1500 psi. This is about 38 tons. The safe bearing load rating is 125 tons. The radial load rating is 87½ tons. The bearing selection was governed by the diameter needed to carry the cutterhead and the requirements for the radial load capacity. These two requirements developed a bearing with over three times the capacity needed for the axial thrust. The driving gears and these bearings have successfully stalled the 300-hp, 230 v, d-c motor.

The design of centerless bar turners presents many very interesting problems. At one time these machines lagged behind the abilities of the cutting tools, but today the modern centerless turners and peelers are ready and waiting for bigger and better cutting tools. This is, we feel, as it should be.

DISCUSSION

PRESENTED BY

H. E. MULLER, Assistant Roll Designer, Youngstown Sheet & Tube Co., Youngstown, Ohio

WALTER SIEGERIST, President, The Medart Co., St. Louis, Mo.

OLIVER A. NEALE, Development Engineer, Babcock & Wilcox Tube Co., Beaver Falls, Pa.

GEORGE JONES, Consulting Engineer, National Tube Co., Lorain, Ohio

Herman Muller: Our organization is particularly interested in billet peeling, and the preparation of billets for the seamless tube process. Have peelers been developed for the application of carbide tools? If so, what are some of the problems to be encountered, particularly with respect to obtaining a satisfactory tool life?

Have you experienced a vibration problem in turning slender bars on the PD turner?

Walter Siegerist: Up to the present time we have not developed a peeler or offered peelers with parts proportioned so that they would have only high surface speeds per minute for the tools for the peeling of billets. Billet peeling obviously has much variation in the chip thickness and, therefore, the shock load is present. The best statement in that respect is, perhaps, that the machine is ready, but apparently the carbide tools are not quite at that point, at least as far as we know.

There is one thing that I might say. The billet peeler in Figure 7 for example, has spiral, bevel pinion and ring gears as the main driving gear. The V-sheave ratio can be changed to get double to two and one-half times, the surface speed per minute that the machine now uses. Obviously, as the cutting tools are improved, or if carbide is economical to use, a machine can be offered that would do the job.

With reference to whether or not we have experienced a vibration problem in turning slender bars on it, that was one of the problems we had to overcome before we had a successful peeler. There are two characteristic points in the PD machine that were put in there to counteract this tendency for harmonic vibrations. The one is the over-speeding of the output grip carriage as compared with the feeding rate of the input rolls. This gives us a differential speed and when the output grip carriage takes hold of the bar, it is a stretching action. Of course, the material will not stretch, therefore, it is being fed through the machine under tension. That helps as far as vibration is concerned, but we all know that piano strings are under tension and that they do also vibrate, so we had to introduce another loading device to dampen out this other, or tension vibration. This device is a snug fitting tube that is in the spindle in the output end.

When the bar has a tendency to get into a harmonic vibration, the side of the bar will hit the tube and the vibration will be dampened out. Of course, a harmonic vibration occurs only at given lengths, so that it is not such a serious problem. Vibration is always present when there is a free end of bar that is not gripped or held in a steadyrest or something similar.

Oliver A. Neale: The use of chasers ahead of the turning tools used as a feed medium was certainly a practical and novel idea, but as you pointed out, only material that could be easily threaded could be used. One question comes to mind in connection with your explanation of the outlet carriage on the PD machine.

You say the carriage starts forward at a speed faster than the bar feed before the grips on the carriage are set. This sets up a tension in the bar, and I am wondering what happens when the end of the bar leaves the last pair of feed rolls as the tension on the outlet end would have a tendency to cause the bar to jump forward.

Another question that has always bothered me is the use of an even or odd number of tools in a turning head.

On your PD machine you use three carbide tools, whereas you start with a four tool head on your bar peeler and you increase by one tool at the rate of every

2-in. in diameter above 6 in. Is there any advantage or disadvantage in using an odd or even number of tools in a turning head?

Walter Siegerist: The torque chipper saves the day at that point. The three torque chipping tools do not cut the groove, they squeeze the groove into the surface of the bar, and, therefore, you always have the resistance of these torque chippers. Now, the other thing that is always in favor of the machine is the fact that we do use hydraulic motors for the output. That is to say the cutting action and the weight of the output carriage has considerable inertia, so that the changes in pace are not abrupt.

It is true, in the PD or push draw turner, that at the end of the bar, there is a short distance that is unsupported and has a different surface. That is one characteristic that the machine cannot overcome, because when there is no more circumferential chipper resistance than the inertia of the bar, that is the only thing that keeps it from twisting; the tool action changes. However, we find that it works and that is the answer.

We find that the number of tools in the head when the operation is bar peeling is not of vital importance provided the individual tools are not overloaded. In fact, in actual practice, as the gentlemen from the National Tube will tell you, the operators must stop the machine when one tool breaks off or gets so dull that it affects the turning of the other tools, and that happens whether there are four, six, seven or any number of tools.

There is, of course, much argument about the number of tools or there has been in the past. Actually, each tool is peeling and in the PD turner each carries its own chip load. We have, however, found, in the case of the PD turner, that if the three tools do not carry a fairly uniform chip load, it does have an effect on the accuracy.

George Jones: The bar turning machine in our plant is a No. 6, similar to that illustrated in Figure 6, whose function is turning mandrel bars 3⅜ to 4½ in. diameter × 62 ft long, used in the processing of seamless pipe. Its basic design is very good and incorporates uniform feeding with close alignment of the work piece with the tool heads. The tool head produces a satisfactory surface which in our opinion compares favorably with any similar equipment known to us.

We wish to emphasize that the design of the tool head is of the utmost importance if close finished bar tolerances are to be maintained without reducing the number of tools provided for. Uniformity of tool slots also should not be overlooked. We are of the opinion that production could be further increased and a better surface obtained by the installation of a precision head equipped with a universal tool adjustment. Adequate shielding of drive and feed mechanisms to prevent access of chips and cuttings is a feature which must be carefully considered in the design of equipment of this type.

The machine has performed quite satisfactorily and has turned bars with a camber of ½ in. or less in 62 ft. After turning, all bars are passed through a No. 5 straightening, sizing and polishing machine in order to obtain the straightness, size and surface finish required.

We also have a billet peeling machine, similar to that illustrated in Figures 11, 12 and 13 for preparing round billets for our seamless mills. It has a feed stroke of 10 to 40 ft per min and is designed to peel rounds up to 13 in. in diam. This unit is of fully automatic construction and as such, demands adequate maintenance of the electrical equipment. Close control of the outgoing feed is necessary due to the jar or jump as the billet leaves the tool head. Manual control of the outgoing feed has been resorted to, but we believe that changes in the type and design of tools will reduce breakage and return the unit to fully automatic operation.

The machine has proven quite satisfactory for smaller sizes of round billets but on larger sizes, the head speed is too great for the tools presently being used. Here again, changes in the type and design of tools are expected to overcome the difficulty.

If round billets having hooked ends or a camber exceeding 2 in. in 10 ft are to be peeled satisfactorily, inclusion of a floating tool head rather than a fixed tool head should be incorporated in the design.

Plan to attend!

Annual Convention

Association of Iron and Steel Engineers

October 1, 2, 3 and 4, 1951

Hotel Sherman

Chicago, Illinois

Preventive Maintenance

FOR ELECTRIC OVERHEAD CRANES

By H. C. MULLINGS
Assistant Superintendent of Maintenance
Electric Division
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

. . . . an ounce of preventive maintenance is worth a pound of repairs . . . .

▲ THE proper performance of overhead cranes is an essential function in the production of steel. Without overhead cranes the steel industry could not exist as we know it today. Cranes handle the production materials many times as steel production progresses from the raw material stage to the finished product. They are also used in the performance of many other varied jobs essential to the maintenance and servicing of steel making equipment. The Pittsburgh Works of the Jones and Laughlin Steel Corp. has 325 overhead cranes operating at the present time. It is important that each of these cranes be kept in good operating condition to perform the job for which it is intended.

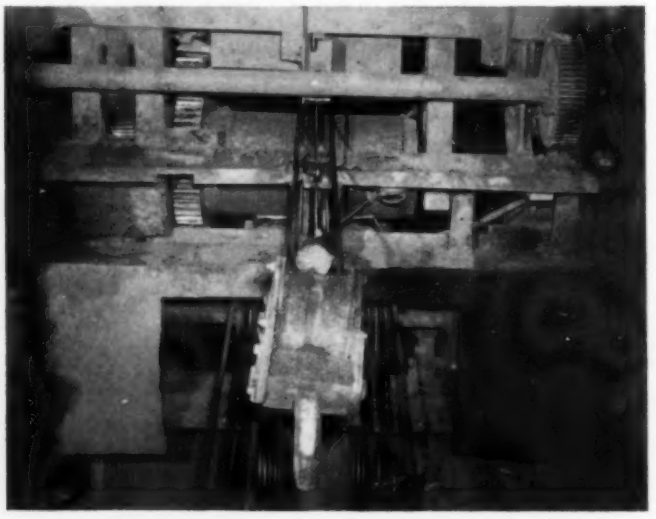
The relative importance of any specific crane largely determines the proportion of maintenance time and materials expended upon it. To establish the relative importance, it is necessary that both the operating and maintenance organizations understand the need for the particular crane in the production set-up. The importance of proper crane maintenance is now being recognized by steel plant supervisors as one of the most vital factors effecting both production costs and production volume. Cooperation of the operating and maintenance departments has grown from the realization that continuity of service can only be obtained through each taking a share of the responsibility for the crane. The operating department must use the equipment properly and must make it available at certain times for the maintenance department which is responsible for a preventive maintenance program.

CONDITIONS OF OPERATION

Overhead cranes are required to handle all kinds of materials such as molten metal, machinery, scrap, brick, rubbish, semi-finished and finished products. These same cranes are exposed to a variety of operating conditions such as flames from a bessemer, acid fumes from picklers and oil from cold rolling mills; to the other extreme of an almost air conditioned atmosphere prevailing in a motor room. Some cranes, such as stock cranes in the open hearth, soaking pit cranes in the blooming mill and shipping cranes in the strip mills

Figure 1 — Bessemer cranes must operate under severe temperature and corrosive conditions.

Figure 2 — Particular attention must be paid to the rope used in the cranes.



are constantly in use. Other cranes such as those in the power houses and blowing rooms are used only as repair cranes and may not be used for a month at a time. To do the required jobs and withstand severe operating conditions, each crane must be properly designed to take care of the particular work it will be required to do and must be kept in good operating condition. It is evident that each crane must be considered as a separate and individual case as to the design and maintenance required.

DESIGN

On new installations the engineering, operating, safety and maintenance departments all share in the specifications and the approval of the design. At our plant we feel that the design of our cranes is the first and one of the most important steps in preventive maintenance. All departments concerned collaborate in the design of the building as well as the mechanical and electrical features of the crane. In the application and design of an overhead crane for a specific job, the following essential factors are given consideration as the first step in preventive maintenance.

1. Building construction.
   a. Foundation of sufficient size and strength to prevent movement of building and runway.
   b. Runway of sufficient strength and rigidity to prevent undue lateral and vertical deflection.
   c. Runway of sufficient height to make required lifts without operating hoist limit switch.
   d. Sufficient end clearance between columns and end trucks.
   e. Sufficient clearance between top of trolley and roof trusses.
   f. Wearing plates should be installed on cover-plates of runway girders.
   g. Repair trolleys should be incorporated in the building to provide facilities for making repairs as quickly as possible on cranes vital to production.
   h. All crane runways, if possible, should be tied together by overhead structure to prevent excessive misalignment.
2. Crane design.
   General specifications are prepared and submitted to the crane builder who designs the cranes to meet our requirements. These specifications, when practicable, seek duplications of cranes or parts already in operation so that new prints, spares, patterns, etc., can be held to a minimum. As work progresses on the design drawings, they are submitted to our engineering and maintenance departments for approval. These departments carefully check structural and mechanical details to see that they meet our standards and to see that parts are made as accessible as possible for convenient and safe inspection and repair work. This phase of the design, we feel, is very important and is one of the helps in our preventive maintenance program. Many items are changed and re-arranged at this point which would otherwise be troublesome after the crane has been built and placed in service. This same procedure is followed for our electrical equipment, including motors, control, wiring, collector systems, etc. We then feel we have a crane of proper engineering design which is the result of the cooperative effort of the crane builder, and the engineering, operating and maintenance departments.

Figure 3 — Rebuilding old trolleys is one way to improve cranes for changed service conditions.

ERECTION AND TESTING

While the crane is being constructed plans are made for its erection. Each move is laid out and scheduled so that no delay or confusion will be encountered during the erection. The erection is arranged so as to interfere as little as possible with production. The crane is very carefully assembled with particular attention paid to the alignment of the various parts. As this work progresses, it is checked by competent men to make absolutely sure that each and every part is assembled properly.

After assembly, painting, greasing and final inspection, the crane is given thorough tests. The crane is put through the paces of its expected operation, so that the mechanical and electrical components may be checked. At this time any needed adjustments are made to the control panels to insure smooth and trouble-free service.

Figure 4 — Changing sheave wheels from brass to roller bearings reduce maintenance.

The fullest possible use is made of curve drawing meters in adjusting the control to insure proper acceleration, deceleration and plugging of the bridge and trolley and proper hoisting and lowering. Records are kept of all tests and at any future time tests may be re-made for comparative purposes. After the final tests and adjustments, the continued availability of the crane is the direct responsibility of the maintenance department.

ORGANIZATION

At our Pittsburgh Works the maintenance of overhead cranes is under the direct supervision of the operating department master mechanic who is a member of the maintenance organization. Each master mechanic has a sufficient number of men on each turn to carry out the normal inspections, preventive maintenance and needed repairs. As is generally true in the steel industry, the electrical division is responsible for the maintenance of cranes completely, including both mechanical and electrical work. On major jobs requiring more than the normal complement of repairmen, the master mechanic has access to the general maintenance department which will supply him with the extra manpower required. The crane repair shop assists in erecting cranes, takes part in major repairs, rebuilds various parts, and is responsible for the maintenance of any cranes not under the jurisdiction of an operating department.

INSPECTION

The most important part of a preventive maintenance program is rigid inspection of the cranes, both mechanically and electrically, by capable and conscientious men. The inspectors, repairmen and cranemen are taught to make orderly and systematic inspections and to maintain proper records. The frequency of the inspection routine varies with each type of crane and severity of service. It is based on the use of the crane, past experience, operating conditions and safety regulations. All cranes are given a visual inspection and all safety devices are checked by the crane operators each turn. Hot metal cranes and heavy duty cranes are given a daily inspection by an inspector or repairman. Other cranes are inspected weekly or monthly depending on operating conditions. In addition to the inspections made by the departmental men, a further inspection is made on designated cranes by a crane inspector from our general maintenance department. This inspection is made on hot metal cranes monthly and on other cranes every two or three months, depending on severity of service and operating conditions. Copies of this inspector's report are sent directly to the superintendent of maintenance, assistant superintendent of maintenance, master mechanic and superintendent of the department involved. These various inspections serve as a continuous check on the condition of the cranes.

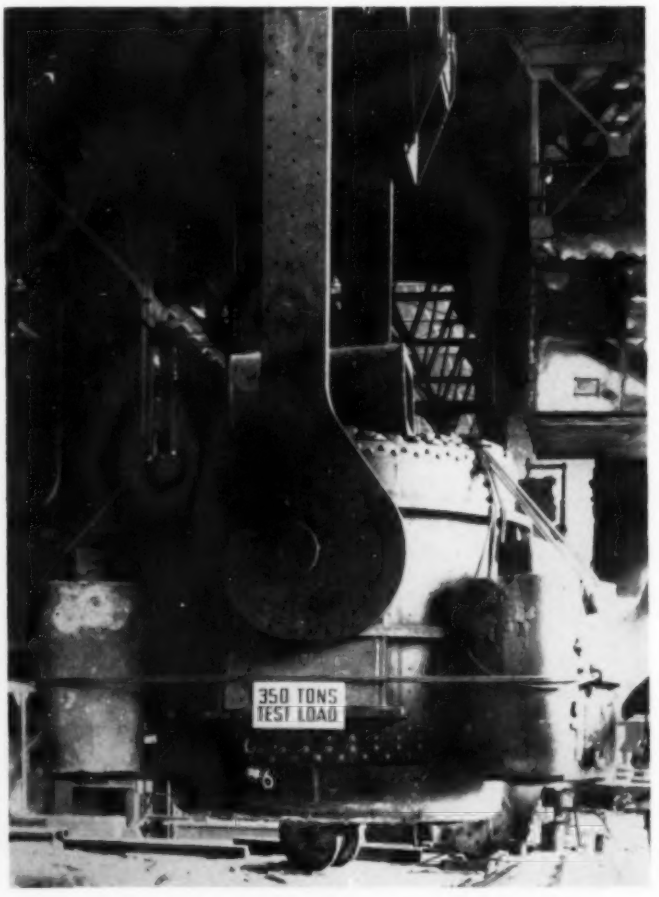
Thorough and conscientious inspections are of the utmost importance in a preventive maintenance program. Only by inspection can a successful preventive maintenance program be carried out since wear, rusting, minor broken parts or other minor irregularities can be found only in this way. To wait until the crane breaks down or does not operate correctly is to invite a major job of repair instead of a minor job of maintenance. Maintenance and repair jobs are governed largely from inspection reports. Should an unsafe condition or an imminent breakdown be noted by the inspector, he notifies the master mechanic of the department at once so immediate steps may be taken to correct the condition.

THE ECONOMICS OF MAINTENANCE

A preventive maintenance program is fundamentally a matter of economics. An unlimited supply of men and materials and a disregard of production schedules could possibly eliminate entirely crane breakdowns but the cost would be prohibitive. Between the two extremes of waiting until equipment breaks down and of following the high-cost policy, there is one that depends entirely upon individual circumstances and economic considerations, not only from department to department, but from crane to crane. Every action with regard to maintenance, whether it is a problem of stocking spares or the thought of doing a certain job, should be preceded with the question "Is it economically justifiable?"

The cranes which serve production units must be more closely watched than those classed as secondary cranes, such as those in storage areas. The production cranes are not only vital when the mill is running, but even when the mill is down, at which time they are needed for repair work. A decision must be reached by both the operating and maintenance departments as to the amount of time that a crane may be removed from its normal duties for the purpose of preventive maintenance. In some cases, where safety is not at stake,

Figure 5 — Cranes are thoroughly tested when first installed in the plant.



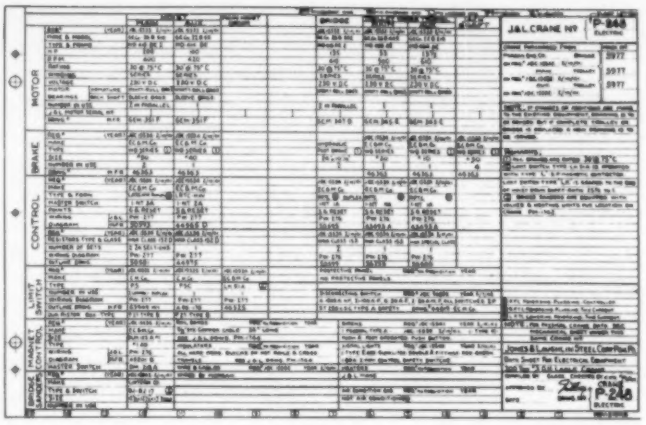
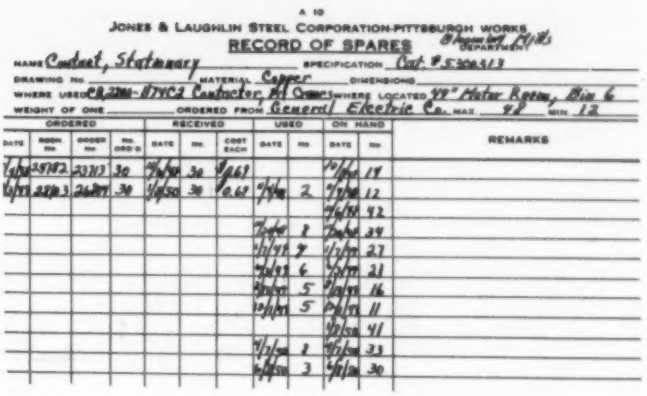


Figure 6 — Data sheets are kept for all cranes.



JONES & LAUGHLIN STEEL CORPORATION-PITTSBURGH WORKS

RECORD OF SPARES

Figure 7 — A spares record must be kept to make sure that parts are available when necessary.

maintenance is deferred because of the pressure of production. In such cases small repairs develop into major and more costly jobs. This practice is not generally recommended but sometimes, due to circumstances, it is the least costly due to the production gained and therefore economically justifiable.

Management is very much interested in our preventive maintenance program because it is realized that the proper maintenance of equipment cuts operating costs and that deferred maintenance often results in loss of production. These men follow very closely the daily reports of operating delays due to equipment failure. They have been most helpful in recognizing many of our maintenance problems and have assisted in arranging mill schedules so we are able to do our repair work. They also help us obtain necessary spares and material to keep production delays at a minimum.

PLANNING AND SCHEDULING

A scheduled repair job must be planned well in advance to accomplish the required work. Sufficient men must be scheduled, repair parts and tools placed on the job, work schedules formulated and plans made to do the job in the quickest and most economical way. On large repair jobs meetings are held with all crafts concerned. Each step of the job is listed and a working schedule planned as to the number of men needed, sequence of each step, time required for each step, and the material required on the job. Several meetings may be held to plan the best possible procedure, as well as to familiarize all concerned with the requirements of the job.

In case of breakdowns such a procedure, of course, cannot be followed. In these cases, decisions must be made quickly as to the most effective way to get the crane back into operation. The necessary men and materials must be put on the job as quickly as possible and plans made on the job. This is the time when correct training methods and experience pay off. Men who are thoroughly trained in definite working methods and safety procedure can be depended upon to use good judgment in meeting such situations.

MODERNIZATION OF EQUIPMENT

One of the biggest problems in the maintenance program is the older cranes. Since the original installation of these cranes, the working conditions and type of work they are performing may have changed considerably so they may be doing jobs for which they were not originally designed. These cranes may require more maintenance and more extensive repairs than the newer and more modern cranes. Much has been done on the older cranes and on some of the new ones to eliminate breakdowns and reduce repairs. Manual electrical controls have in many cases been changed to magnetic controllers. Many sleeve bearing motors have been changed over to anti-friction bearings at a nominal cost. New type brushholders have been installed where necessary to minimize delays. Many changes have been made in the design and material used in shafting and gearing. Armature and field winding changes have been made in drive motors. Alloy steel resistors have taken the place of cast iron, and the new ones have been designed for higher duty cycles. Changes have been made in the end ties of cranes which have resulted in more rigidity and better alignment.

Many of the old runways are also a source of trouble. Some of them get out of span and elevation. Wheel wear is watched closely and when this shows signs of bad span alignment, steps are taken to check and correct this condition. Foundations for the runways may sink and it may be necessary to correct this by pumping cement under the foundations and by raising the columns or shimming under the seat of the runway girder. Many old runways were also put up without wearing plates under the rails, and when the coverplates were worn through, new coverplates had to be installed. This is usually a major operation and much more expensive than the replacement of wearing plates. We have installed, when conditions permit, a wearing plate to eliminate such repairs.

When changes are about to be made on existing equipment they are generally referred to our engineering department for approval. The engineering department checks cranes already in use to see if existing parts can be used for the new installation. If necessary, new drawings are made or old ones revised. New and corrected prints covering changes in design are sent to the departments concerned.

ABUSES

Abuse of cranes is a source of trouble for the operating as well as the maintenance department. Due to frequent

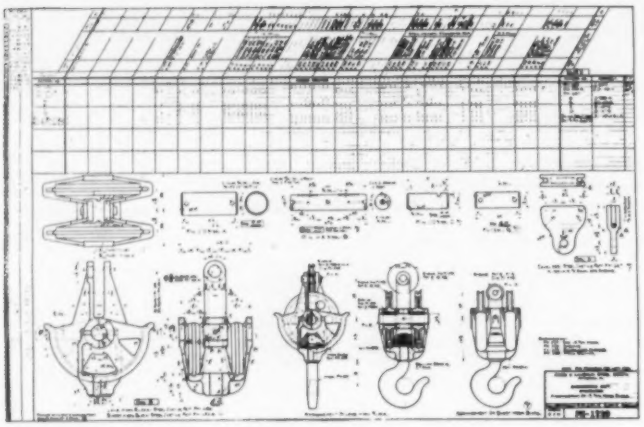


Figure 8 — Standard sheets are kept on component parts such as the old hook blocks illustrated.

inspections and the preventive maintenance program, normal wear and minor irregularities can normally be found and remedied before most breakdowns occur. However, abuses often upset this planning. Overloading is more or less common. Aside from causing excessive wear, sometimes overloads so exceed the rating of the crane that major breakdowns result. Side pull on cranes is one of the most common abuses and one of the hardest to control. Using a swinging load to serve as a battering ram is severe service, not only on the sheaves, trackwheels and cables, but it imposes severe shocks to the structural members. Another shock problem is the practice of pulling chains or cables from under heavy loads. This causes not only shock to the crane when the cables release, but whips the hoist cables so that kinking or breakage may result. Many other abuses can be found of more or less severity, but most of them cause similar maintenance problems.

Much abuse of cranes can be stopped by the proper education and training of the crane operators and crane directors. Crane operators and crane directors should be well trained in the correct methods of handling cranes with particular attention paid to the causes of damage.

There may be some circumstances where it is economically justifiable to abuse a crane, but this decision should not rest with the operators, but should be agreed upon by the department heads concerned.

LUBRICATION

The function of lubrication in preventive maintenance must be given due consideration. In broad terms, lubrication involves the type of oil or grease used and its method of application to the bearing surface. From the preventive maintenance viewpoint, the practice should accomplish the most in ease of operation and length of service of the equipment, together with reasonable cost.

In a plant where a wide variety of crane types and different operating conditions exist, it is difficult to discuss lubrication from any standardized basis. As a general rule, actual operating practice is established upon the following factors:

1. Type of bearing surface.
2. Operating conditions.
3. Continuity of service.
4. Wear and failure.

With lubrication control in effect over a period of time, the various departments evolve practices and use lubricants which fit the needs of the equipment. However, the foregoing factors must be evaluated in reduced maintenance. Perhaps the greatest fallacy in maintenance procedure is the acceptance of existing conditions without recognition of possibilities for improvement.

Design generally determines the use of oil or grease. The type which is used or which is chosen for new installations becomes a matter of mutual agreement based upon competent lubrication engineering and the specifications of the operating and maintenance departments. Sometimes the trial and error method, due to extreme conditions, turns out to be the only method of solution. On an open hearth mixer crane, the open gearing on the trolley is run with no lubricant because the abrasives in the air get into the lubricant and form a very effective lapping compound. With tool steel gears and the lubricating qualities of the graphite, which is ever present, acceptable results are being obtained. This practice can hardly be recommended but, in this particular instance, it has proved to be the best solution.

ELECTRIC REPAIR SHOP FUNCTIONS

The armature repair shop is a central organization for repairing and rewinding crane motors and magnets. The presence of this shop has been economically justified by its savings shown by cost records. It is more economical to do this repair work in our own plant, but in addition, the speed with which the work can be done in an emergency gives good insurance against long delays. The convenience of such a shop, however, may cause abuse of the privilege by the operating departments. It is a relatively easy matter to change an armature and send it to the shop, so there is a temptation to overlook the preventive maintenance necessary and wait until the armature fails. This practice will save work for the repairman, but it transfers the job to the repair shop where a great deal of time and material is used in repairing the armature. This practice is minimized only by the supervisors realization of the higher departmental cost and by the frequent inspections of the equipment.

RECORDS

For intelligent planning and scheduling of work it is necessary that adequate records be kept. One of the most simple records is the daily log on which each man records the work performed on each turn and the equipment on which it was performed. This log serves to pass information on from one turn to the next, keeps the supervisor informed, and gives the repairman's views on any delay or maintenance problem. From this log it is an easy matter to transfer the information to cards or record books referring to a particular crane. This last record serves to give the maintenance time spent on the crane, notes any changes, shows up weak points or discrepancies in design, and shows if the scheduled program is being carried out. It also serves as a basis for the planning of future preventive maintenance.

A crane data book is kept which gives information on all the cranes in the plant. This book contains an outline of each crane, span, cable size, rail and trackwheel size, motor data, control data, wiring sizes, print numbers and similar concise information. This book also has included a map of each area showing the loca-

tion and number of each crane. This book has proved valuable in giving a maximum of information in one volume. This information is used as a reference when ordering new cranes, since, as far as practicable, it is desired to buy new cranes which duplicate, at least in part, the existing cranes. This duplication of equipment is desirable in many ways. It cuts down the stock of spares needed, reduces the number of prints and other records, and furnishes equipment already familiar to the maintenance men.

The engineering department gets tracings from manufacturers in order to have a means of supplying all the prints needed. Copies of all prints relating to a new crane are sent to the department involved for their files. Our engineering department is doing a notable job in helping to reduce the number of prints required by so-called "Standard Sheets." These sheets are actually prints on which a standard part such as a brakewheel, or several variations of a wheel are drawn, giving all the necessary information and also listing the various cranes which use a particular wheel shown on the prints. This not only cuts down the prints required, but shows which cranes use duplicate parts so that in emergencies, spares may be borrowed from other departments. Another valuable use of "Standard Sheets" has been to cut down the number of patterns kept in stock by the foundry, since one pattern may be used for several similar parts.

SPARES

The importance of an adequate supply of repair parts and proper control of such parts in regard to purchasing and stocking cannot be over-emphasized. It is the systematic control of such parts that makes them available when needed, and this eliminates the threat of over-long production delays and at the same time helps to keep repair costs at a minimum. At our Pittsburgh Works, the master mechanic of each department is responsible for the maintenance of spares for the cranes in his department. The problem of a sufficient supply of spares varies with the type of equipment, severity of service, relative importance of the crane and past experience, but as a rule, due to large scale operations and large variety of cranes, it involves carrying a considerable number of items in stock.

The spare parts must be cared for properly. This means storage in a convenient and protected location, proper packing, use of rust preventive on machined parts, partial or complete assembly of units where advisable, and proper identification. A card system of perpetual inventory showing the number of each item on hand, dates of purchase, dates of use, cost and reordering information should be used. This card record along with service records, establishes a means for determining the quantity of any item stocked so that reasonable protection will be afforded against unnecessary delays with a reasonable investment in spares and supplies.

SAFETY

Crane maintenance can be one of the most hazardous jobs in the steel industry if proper safety precautions are not followed. The "Safety First" slogan should be taken seriously and conscientiously practiced even though, at times, production may suffer. Safety pays off in the better morale of the men. No man will do a good job if he feels he is in danger, nor will he work well for a foreman if he feels the foreman is not concerned for his safety. The crane inspectors are instructed to pay particular attention to unsafe conditions. The maintenance foremen are trained to plan and carry out jobs so that all work is performed safely.

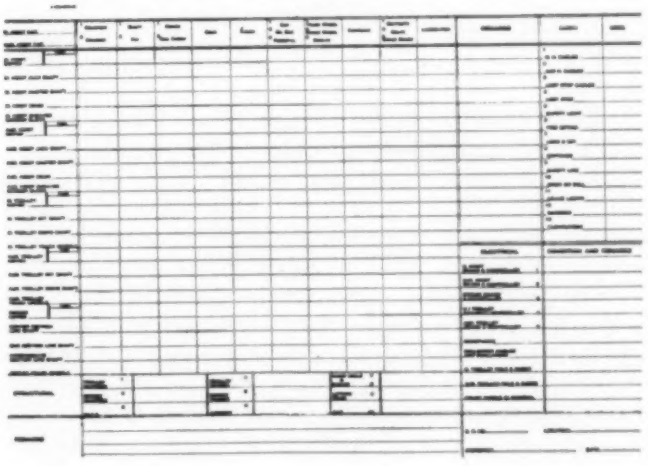
A repair job is not completed until all tools, equipment, and materials are removed from the crane, footwalks and runways, and all safety guards are back in place. From a safety standpoint, no material should be left on footwalks or on places where it might fall to the floor. On large repair jobs a well trained safety man is assigned to the job to follow it from a safety viewpoint, and he has the necessary authority to see that safety rules are followed.

It has been found that hoist limit stops of the power type are the only type giving adequate protection for all overhead cranes. Even this improved type of limit stop must be given a maximum of attention to prevent failure. Hoist limit stops on all overhead cranes, even though they are checked by the crane operator at the start of each turn and are given other routine inspections are removed from the crane every eighteen months, reconditioned and rebuilt. Recently a program similar to this was started on all hot metal cranes. At stated periods, the hoist shafts and gears are removed and given a minute inspection to determine if any cracks, excessive wear or any other unsafe conditions are present which could not be detected by normal inspections.

DELAY INVESTIGATION

Delay reports that indicate serious trouble or show many repetitions of certain delays are followed up by a full investigation to determine the real reason for the delays. As an example of insufficient investigation, armatures sent to the repair shop may be replaced with spares, but the actual cause of the failure may not have been a faulty armature. It could have been caused by control adjustments, worn gearing or abuse of the crane, which would result in a similar failure at a later date if the real cause of the failure is not found and corrected. It is very important that the "why" of breakdowns be discovered so the same failure will not be repeated. A

Figure 9 — The crane inspection report forms a basis on which to plan repair work.



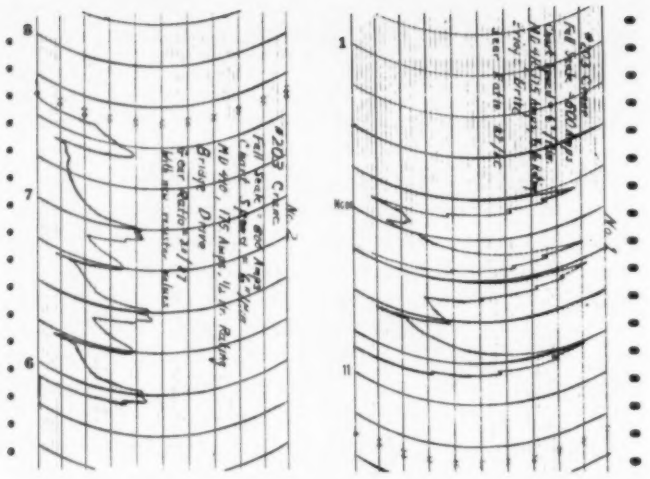


Figure 10 — The ammeter readings for the bridge drives show the improvement obtained by changing gear ratio and resistor values.

follow-up of delays in this way gets to the origin of the trouble and eliminates the cause which often may be far removed from the part that fails.

CONCLUSION

The overhead cranes in a steel mill operate under such a variety of conditions and perform such diversified jobs that each crane must be treated as a distinct and individual unit. Only the fundamentals of good preventive maintenance, which apply to any piece of equipment, logically embrace the entire category of overhead cranes.

A properly executed preventive maintenance program is one that insures the maximum service from overhead cranes at the lowest cost. Support from the operating departments is essential to a successful preventive maintenance program. A constructive program of crane maintenance must include good design, foresighted planning, intelligent supervision, definite routine and rigid inspections by conscientious, well trained personnel. Often neglected, but of equal importance are proper records, adequate spares, safe workmanship and attention to costs. Above all, supervisors must practice and instill into their men the thought behind a somewhat twisted saying, "An ounce of Preventive Maintenance is worth a pound of repairs."

DISCUSSION

PRESENTED BY

ERIC TAYLOR, General Electric Foreman, Atlas Steels, Ltd., Welland, Ontario, Canada

H. C. MULLINGS, Assistant Superintendent of Maintenance, Electric Division, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

I. N. TULL, Electrical Superintendent, Republic Steel Corp., Corrigan-McKinney Works, Cleveland, Ohio

E. L. ANDERSON, Superintendent, Electrical Department, Bethlehem Steel Co., Johnstown, Pa.

R. J. HARRY, Vice President, Alliance Machine Co., Alliance, Ohio

Eric Taylor: One item of the paper seemed to refer to deliberate abuse. We have a great deal of trouble with ignorant abuse, due to improper training of crane operators.

I would like to know to what extent Mr. Mullings had a hand in training crane operators and the supervision of them after they are trained.

H. C. Mullings: You have given me a controversial subject. All of our cranemen are put through a training program before they are allowed to run the crane. They are put in the crane cab with the operator. They are instructed in the operation of the crane by some of the old operators. They are also taught and talked to by the electrical foremen, and given full instructions.

We also have abuses, but we try to keep them to the minimum. Any time it is noticed that the cranemen are abusing the crane or doing things that they should not do, we give them a reprimand. If a craneman gets three reprimands, he starts getting time off. If he gets several of them, he is fired.

I. N. Tull: A most difficult thing to do in times of heavy production is to get a crane often and long enough to effect maintenance of sufficient scope to keep that crane in satisfactory continuous operation. It has to be lubricated regularly; it is not safe if operated too long without cable, limit switch, shaft, gear, shoe, motor, controller and general inspection for loose bolts, guards and such. Yet, many plants report the same difficulty, and costly maintenance and excessive delays result from the lack of proper understanding between the production and maintenance departments. There must be very close co-operation to change this picture.

Under "Design," Mr. Mullings has touched on most of the items that should be paid special attention. I would like to add, that in the design of crane assemblies, such an item as gear guards be given more thought than heretofore, as some of the guards are so poorly designed as to make it necessary to spend several times as long to disassemble and reassemble as it takes to effect a repair, and puts such a burden on inspection as to prevent proper inspection entirely.

One item of building clearance mentioned in the paper has to do with proper lift height. Even with plenty of normal clearance, some crane-followers and operating personnel will use slings so unnecessarily long as to nullify the designed clearance.

Open top runways, particularly those of wide span, need close attention for maintained alignment, as a very small amount of settlement at the base may cause very serious misalignment at the crane rail. Temperature changes also affect this item seriously.

In the mention of duplicate spares wherever possible, these save not only the investment in the spares themselves, but in the satisfactory storage space required for them.

With the present day practice of more and better overloading, many supposed limit switch failures have been traced to motor "critical" torque failure, rather than to the limit switches. An interpole motor overloaded to a point when dynamically lowering its load, to where its interpole flux will neutralize a great portion of its main pole flux, cannot develop the lowering torque required, and runaways result in fanning out armatures and other disasters.

Certainly proper and careful inspections should be regularly made, but they are entirely superfluous if not followed up by the corrective steps indicated.

While we are talking of the electrical and mechanical maintenance of cranes, there is a third maintenance item not to be lost sight of. That is the maintenance of discipline of repairmen and cranemen. Rules that have been set up have in general only been set up after experiences leading to the necessity of the rules. Usually an experienced craneman will operate safely. Many cases have been recorded that men of long experience in maintenance will take short cuts, violate safety rules affecting not only themselves but fellow workmen, and sooner or later have accidents of very serious or fatal nature. It cannot be taken for granted that rules are not violated. More and better supervision is needed to check regularly the safety attitudes and performance of all personnel involved.

Under "Abuses," side pulls are one of the worst, for not only the girders and trolley parts are subjected to stresses in directions not designed for, but rubbing of cables on edges of girders may bring about a break of the cables sometime later. One of the most severe jobs of some soaking pit cranes is the moving of loaded strings of mould cars. This is very destructive to the crane as a whole, and particularly to, in the case of stiff leg types, the ram. It does nothing to reduce maintenance cost.

Mention is made of the electric repair shop and its place in the functioning of maintenance. It is certainly a fact that if motors and other equipment are kept reasonably clean and properly lubricated on the job, that the shop work necessary will be a minimum.

The standard sheets of clearances and parts should be familiar to all key personnel having to do with maintenance and engineering; and field changes should promptly be incorporated in these records. Every one might remember a changed shaft and bearing for a short time, but when a breakdown occurs and the wrong part is gathered in from its storage and turns out to be the wrong one, not only is a costly time delay experienced, but everybody is thrown out of phase and definitely subject to criticism.

Mr. Mullings' remarks about "Delay Investigations" are very much to the point and well taken. Occasionally a series of meetings between operating and maintenance key men can do a world of good in uncovering sources of delays and consequent loss of efficiency. Certainly, Mr. Mullings' reference to ounces and pounds are appropriate, as a return of 1600 per cent is an AAA investment.

E. L. Anderson: A good many of us have in operation cranes that are of old design, most likely operating under bad conditions other than those originally figured on, and therefore, not as substantial as a modern design crane. Such cranes present a problem to the maintenance men, but much can be done to keep them in operation. Heat treated gearing, alloy steel bolts, sealed bearings and the reinforcing of structure and other members are a few changes that can be made to improve operating conditions and reduce maintenance.

One point that I feel cannot be stressed too forcibly is that the maintenance men must sell the operators and operating supervision the fact that the overhead crane is one of the most important pieces of equipment in the plant, and that to abuse it is a sure way to incur costly delays and repairs. It is a real problem but I feel that the items discussed in Mr. Mullings' paper, if followed, will lead to a better understanding of crane maintenance problems and their solutions.

Robert Harry: The methods of inspection outlined should result in the detection of many minor troubles which, if neglected, would be the cause of major delays and consequent loss of production.

Under the heading of "Building Construction" Mr. Mullings has listed eight items that are vital and should be carefully considered by the engineers when designing buildings in which electric overhead cranes operate. I should like to add another item to this list and that item should be the matter of hook approaches. All too frequently the engineer tries to conserve floor space and to cover as much floor area with the crane as possible. The design of a great many soaking pit buildings is subject to this criticism as in too many cases, the ingots are brought in on a track adjacent to one line of building columns, and after heating are delivered to the mill by an ingot buggy which runs in a track adjacent the opposite line of building columns. This means that every ingot rolled gives two punishing body blows to the building where the hook approaches require the trolley to contact the bumpers on the crane girders. When you consider that some of the larger soaking pit crane trolleys weigh about 100 tons and have a free running speed of 2 to 4 fps, it is not hard to visualize the devastation that can be done by a careless crane operator, or the failure of the brake or control apparatus.

The results of these impacts are manifested in sheared off bumpers, sheared off rail clamps, loosening of the girder connections to the columns, loosening of column connections to foundations, and in many cases the columns are caused to lean and the building rendered noticeably out of plumb. It goes without saying that these impacts which are so destructive to the building structure certainly do no good to the crane. Other building structures that should be given special consideration when being designed are stripper buildings and open hearth buildings for ladle cranes.

In general, it is good engineering practice to allow ample clearance between the trolley and the bumper for regular service of the crane and use the extreme travel only for emergency lifts.

I was very much impressed with the safety precautions taken on repair jobs and I am sure that the J&L procedure could be copied with profit to many steel mills. I was particularly pleased with the procedure regarding the periodic reconditioning of limit switches and, I am sure that many overhoisting accidents will be avoided in the future if Mr. Mullings' recommendations are followed.

Automatic Control Systems

FOR MULTI-FUEL FIRING

. . . . multi-fuel firing provides economy for the operator and flexibility for the fuel engineer . . . .

By R. L. WILLIS
Assistant Combustion Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

▲ THE use of automatic controls in the supply of a single fuel to boilers, and open hearth and reheating furnaces is well known. Many arrangements and various types of systems have been developed, including hydraulic, pneumatic, and electric. Various manufacturers specialize in such equipment and standard and time-tested systems are available.

The ability to consume two or more fuels individually or in combination at any time, however, is becoming increasingly important. The integrated steel plant has always been faced with this problem. The need to consume fuels produced in the production of coke and pig iron in order to keep fuel purchases to a minimum has been ever present. The present comparison of costs of the various fuels has not created the need for economic conservation, but has only "shuffled the deck," requiring review of the problems under the altered conditions.

Add to this old problem the present interest in natural gas and the picture is complete. Should liquid and solid fuels be replaced with natural gas? What are the economies? How dependable is the supply? The present indications are (1) that natural gas will become available at a very favorable cost, (2) that the supply of natural gas will be seasonal to a considerable degree, and (3) that the supply will vary with com-

Figure 1 — The basic control system for multi-fuel firing is illustrated here.

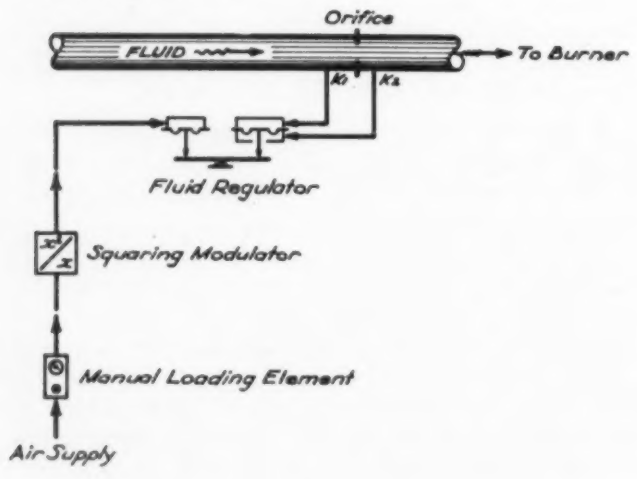
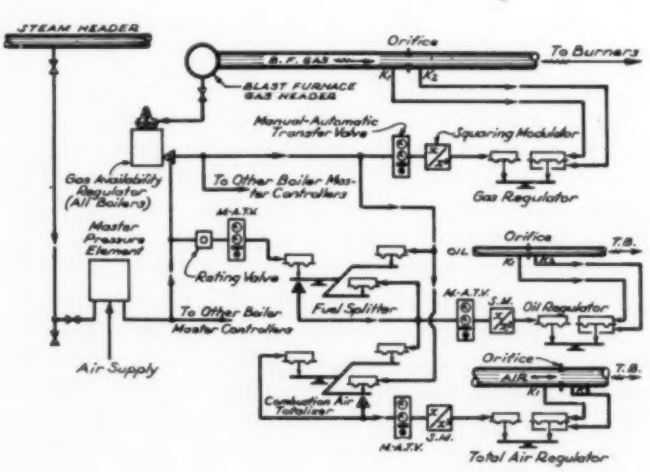


Figure 2 — System shows combined firing of a boiler with blast furnace gas and oil.



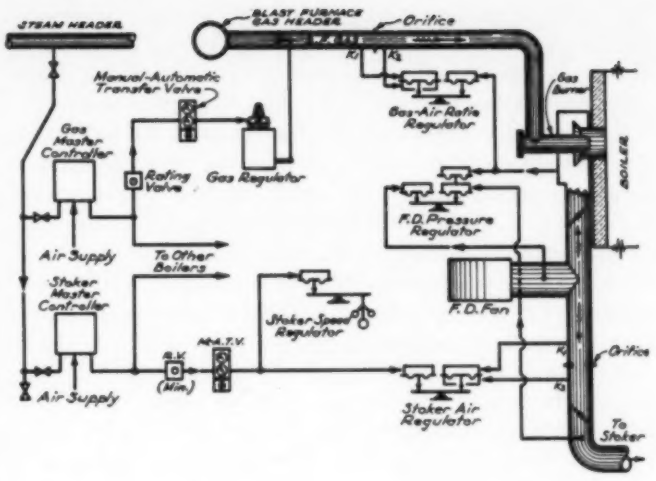


Figure 3 — This system uses blast furnace gas and a stoker to fire the boiler.

bination of pipeline and pumping facilities and increased utility-domestic demands. The answer then is multi-fuel firing that can make use of any fuel or combination of fuels as indicated by changing relative costs or availability. In case of failure of any one source by strike in production or transportation, or by seasonal supply including transportation problems, another fuel is immediately available to maintain operations. By the use of automatic control systems, these changeovers in fuel used are performed by the regular operator, helper, or heater without any changes to equipment. It is only by the use of such automatic controls that the maximum savings can be obtained in varying the fuels according to price fluctuations.

The purpose of this paper is to present typical methods of multifuel control, with no indication that these are the only ones available. It is not intended to discuss the relative merits of certain phases of control, but only how such controls can be accomplished. Also all sketches are diagrammatic. They present the principles of the control systems, and not constructional details which vary according to the manufacturer of such control equipment.

In general the control of several fuels is only the control of each fuel in a simple manner with a suitable interconnection of the various systems. The basic control system for the purpose of this paper is shown in Figure 1, and is applicable to any fluid, whether gaseous or liquid.

This system consists of a controller employing a suitable air-loading pressure 0 to 10 inches of mercury pressure, for example. This air-loading pressure balances the differential of the fluid-measuring device, such as an orifice plate. By means of the hand wheel on the manual loading element, the operator sets the fluid supply at the desired rate and the control system operating a valve maintains this rate of flow. In an identical manner the flow of any number of fluids can be individually controlled, including combustion air or atomizing steam. By the addition of a squaring modulator, the manual pressure becomes proportional to the fluid flow.

BOILERS

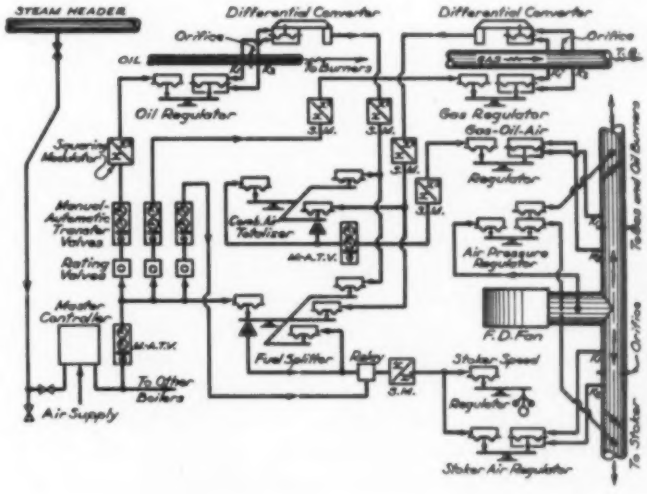
Boilers are an almost ideal outlet for comparatively low-quality or low-cost fuel. In the integrated steel plant a surplus of blast furnace gas is usually available for consumption, as is also coke breeze. In plants where these fuels are not available, the economic balance between coal, fuel oil, and natural gas will determine the proper fuel to use when the boiler is equipped to operate on any fuel available.

Basically, the control system is set up to operate from steam pressure. This steam pressure operates a master controller to develop an air-loading pressure which is a direct function of total fuel requirements. Let us assume a boiler using blast furnace gas and oil as fuels. The intent is to burn as much blast furnace gas as possible with the oil being the make-up or standby fuel. As shown in Figure 2 the master air loading is transmitted to the gas-availability regulator. Here the blast furnace gas pressure, if normal, permits the full air loading to be transmitted through the squaring modulator and manual-automatic transfer valve to the gas regulator, calling for full gas consumption. If the gas pressure is low, the air loading is reduced and gas flow correspondingly decreased. The master air loading is also applied to the fuel splitter as is the loading from the gas-availability regulator. The fuel splitter consists of a fulcrum system balancing the air-loading pressure from the master controller against the air-loading pressures representing the gas and oil fuels. The fuel splitter applies the difference in these loadings through a squaring modulator and manual-automatic transfer valve to the oil regulator. When gas pressures are high, the full fuel requirement is met by blast furnace gas, and when gas pressure drops, the gas consumption is reduced with corresponding increase in oil consumption. The total Btu input remains constant as long as the steam pressure has not changed.

This simple totalizing fuel splitter, therefore, when used with the gas-availability type of regulator, utilizes the blast furnace gas to its maximum.

It is usually desirable to have the means provided

Figure 4 — The scheme shown here is for a boiler using three fuels.



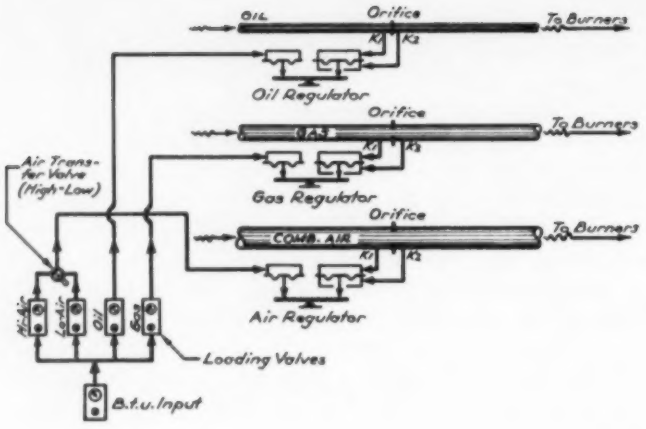


Figure 5 — Simple open hearth furnace control.

for the operator to set the amount of gas burned at some constant rate. This is accomplished by the manual-automatic transfer valve and by hand loading the gas regulator. The fuel splitter automatically makes up the difference in Btu requirements with oil to maintain constant steam pressure. In this case also, the gas availability regulator can be arranged to reduce the loading when gas pressure is low, thus assuring safe gas pressures and maintaining the gas to stoves and other plant uses as primary consumption.

Due to the differing air requirements per Btu of the various fuels, the combustion air supplied must be varied accordingly.

In a manner similar to the fuel splitter, the combustion air totalizer is loaded for gas and oil and the total loading applied to the total air regulator. The combustion air is thus provided in accordance with the amount of each fuel burned and proper combustion conditions maintained.

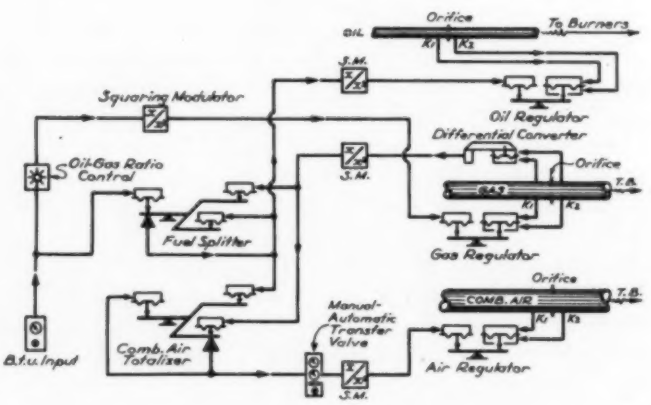
If a group of boilers is to be controlled, the master air loading and gas-availability loading are transmitted to duplicate fuel controls for each boiler, in which case a rating valve is included to adjust loadings between the various boilers.

Let us now consider a boiler with chain-grate stoker and equipped for blast furnace gas. In Figure 3, again, the header steam pressure develops a master air loading pressure, both for gas and for stoker operation. In this case the rating valves balance the load between the various boilers as in the previous case. The stoker rating valve is adjusted for a minimum setting which represents the minimum stoker operation permissible too maintain a suitable fuel bed both to protect the grate and to permit rapid response in case of gas shortage. In addition, the gas rating valve may have a maximum adjustment which will limit the maximum flow to match the minimum stoker operation. The air loading for gas is transmitted to a positioner which controls the gas damper ahead of the burner. Gas differential at the burner orifice and air pressure at the gas burner are connected to the gas-air ratio regulator which controls a damper in the air duct to the gas burner. The air loading from the stoker rating valve is transmitted to the stoker speed regulator which maintains the grate speed as required. This same air loading is applied to the stoker air regulator. The stoker wind-box pressure and gas-burner air pressure are transmitted to the total air regulator. This is spring or weight-loaded and so arranged that the forced-draft fan pressure is maintained at 1 in. water greater than the higher of the above pressures. In this case, the two rating valves determine the ratio of gas to coal consumption and, as firing rates vary due to steam pressure, both will fluctuate at the set ratio unless the minimum stoker setting is reached. This is corrected by setting the stoker master controller for a pressure somewhat lower than the setting of the gas master controller. In case sufficient gas is unavailable, the steam pressure drops and the stoker picks up the load at the predetermined setting. This system is best used where a fuel dispatcher instructs the operator as to quantity of gas to be burned. The operator then adjusts the rating valves to use this amount of gas.

In both cases the differences in air requirements for the various fuels are recognized and taken care of by the combustion air totalizer in the first case, and by separate control and forced-draft fan control in the second.

In Figure 4 is shown a three-fuel arrangement of boiler firing. The rating valves are set for the ratio of fuels desired, with a minimum on the stoker firing. The loadings pass through the manual-automatic transfer valves and squaring modulators to the oil, gas, and stoker regulators. The metered oil and gas flows develop air loadings which, passing back through squaring modulators, are applied to the fuel splitter. The stoker then operates to make up any shortage in total fuel supply. The air loading from the fuel splitter to the stoker regulator passes through a suitable relay which chooses either this loading or the minimum stoker loading, whichever is greater. The advantage of loading the fuel splitter from the metering devices by means of the differential converter is that any shortage of fuel due to burner blockage or low fuel pressure is automatically corrected. Manual air loadings from the rating valves do not correct for such a condition. While oil, gas, and stoker-fired coal are used in this case, almost any fuel or group of fuels can be substituted. One fuel must be

Figure 6 — Several automatic features are incorporated in this open hearth firing control system.



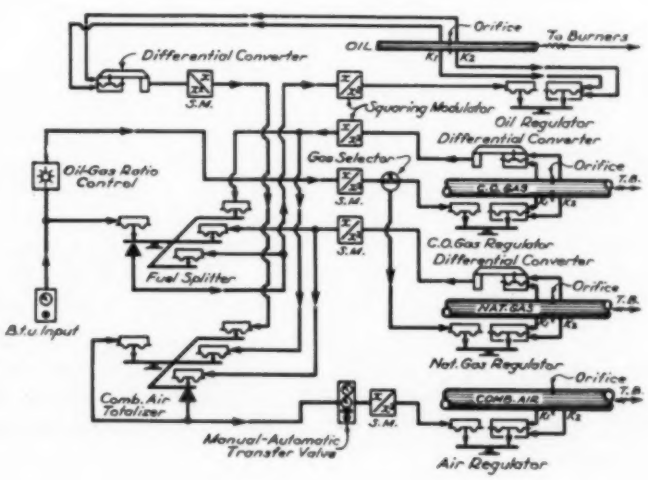
selected as the stand-by or make-up fuel, however. A change from coal to coke breeze is a matter of supply to the stoker only.

While furnace draft is an independent subject and its control is not discussed in detail, experience has shown the location of the draft connection to be very important. Where gas and oil are the fuels, a single furnace-draft control connection may be taken. However, where a chain-grate stoker, burning a relatively low-grade fuel is used, and where gas is injected above the throat of the arch, it is necessary to have two combustion-chamber pressure connections, one on the top when gas is the major fuel, and the other under the furnace arch when coal or coke breeze is burned. It is essential that the connection be switched automatically, and the master air-loading pressure to the stoker regulator may be used for this purpose. It is rarely possible that a furnace can be designed for variable-load operation, and maintain the proper pressure throughout the setting, especially if the fuel being burned on the stoker is at all critical, which is generally the case.

It is usually the practice to provide some form of gas safety regulator to recognize low gas pressure, and to shut off the gas under such conditions. Frequently this consists of two separate units, one to actually close off the gas valve, and shut off the gas entirely, requiring resetting of the safety device, and a second unit which comes into play before the operation of the complete closure by reducing the amount of gas burned. This will probably prevent shutting off the valve by means of the low-pressure safety regulator. In such an event the make-up fuel will of course cut-in and maintain the loads on the boiler.

Most boilers are also provided with a furnace-pressure safety device so that, should a tube be blown or any other extraordinary condition exist in the furnace, the combustion control will be shut down. This is particularly true in the case of gas burning, where at least the gas would be shut off under such conditions. A low combustion-air pressure or flow may also be arranged to reduce or shut off fuel flow as a safety measure. To this may be added a time-delay relay which insures purging the furnace of any combustibles before again permitting the flow of liquid or gaseous fuels.

Figure 7 — The gas selector valve simplifies the multi-fuel firing system when only one gas is fired at a time.



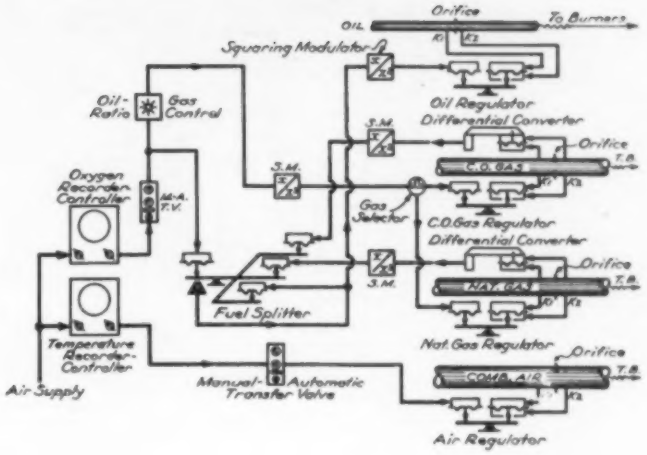


Figure 8 — Firing in this scheme is automatically adjusted for bath reactions.

OPEN HEARTH AND REHEATING FURNACES

The controls commonly considered in open hearth and reheating furnaces are:

1. Furnace pressure.
2. Rate of fuel supply.
3. Fuel-air ratio.
4. Time or temperature reversal.

To these may be added steam-oil ratio in liquid-fuel firing. Since furnace pressure and furnace reversal are not associated with the fuel supply these phases will not be discussed.

Figure 5 is a simple method of control for open hearth furnaces developed before World War II to utilize two fuels and a combustion-air control. In this case the master loader determines the total amount of fuel and air supplied, maintaining the fuel and air ratios set by the loading valves. The operator, however, must set the loading valves to obtain the proportion of each fuel used. When instructed to change the quantity of gas being burned, the operator is required to reset the loading valves for both gas and oil. The air-loading pressures are set in the control system so that a unit air-loading pressure to the gas regulator and to the oil regulator equals the same Btu. The low and high combustion air controls are used on open hearth furnaces to compensate for increased air required during certain stages of the heat. This still requires considerable thought the judgment on the part of the operator to make the necessary adjustments to meet his varying furnace conditions. Furthermore, it does not provide for actual gas flows less than the setting, due to low pressure or other causes. As set up it does not include squaring modulators and the loading pressures are proportional to the square root of the flow.

Figure 6 shows an improved design of the control system to reduce the number of adjustments required by the operator. Although some additional automatic

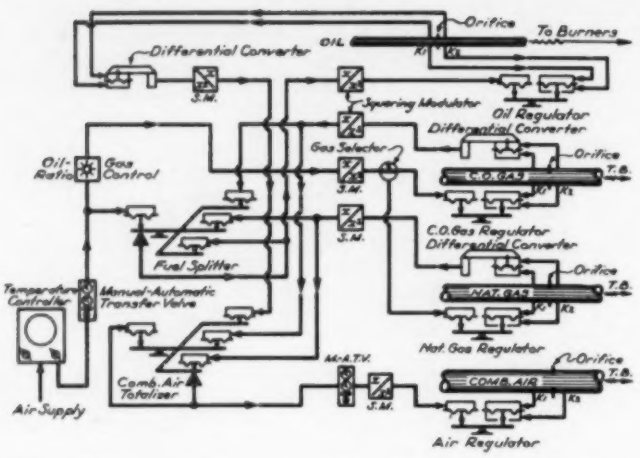


Figure 9 — Steel temperature may be used to control Btu input.

equipment is included, the system is simplified by eliminating the various loading valves for fuel and substitutes one gas-oil ratio valve, one side of which is marked oil and the other marked gas.

A subpanel with indicating gauge and hand-wheel is provided for the total Btu input to the furnace. This air loading is applied to the total side of the fuel splitter and simultaneously through the gas-oil ratio valves to the gas regulator. The operator can change the air-loading pressure to the gas regulator, reducing or increasing the quantity of gas as directed by the central control room. It is only necessary to turn this one control valve to increase or decrease the amount of gas burned.

The measured gas flow, by means of the differential converter, develops an air loading which passing back through a squaring modulator, is proportional to gas flow and is used in conjunction with the fuel splitter. Should this amount of gas provide an air-loading pressure equal to and balancing the air-loading pressure from the Btu-input control, no make-up fuel will be required. However, if it is not balanced, the fuel splitter will add sufficient air-loading pressure on the other diaphragm to balance the input force, and this air-loading pressure will call for a definite amount of fuel oil to be burned. Again this fuel oil will be measured. Once the total Btu-input loading is set, this fuel splitter will provide the correct total Btu to the furnace. Should the gas flow fail or be reduced for any reason, the fuel splitter will make up the shortage with fuel oil, thus assuring the proper supply of heat to the furnace. As squaring modulators are used for each fuel regulator, the difference between Btu-loading and gas-loading pressure is a measure of oil requirement. It is the customary practice to have on the control and instrument panel indicators or recorders showing the actual flows, but in this type of system, these are not absolutely essential, although very desirable.

The air loading to the combustion-air regulator is obtained by totalizing the gas-loading and fuel-oil loading pressure, adding these in the proper proportion, and developing an air pressure to balance the air flow of the combustion air.

In the loading line to the air regulator are two ratio valves and a throw-over lever for high and low air to produce reducing or oxidizing conditions in the furnace (not shown in Figure 6). Also in this line is a manual-automatic transfer valve by means of which the operator can disconnect the regulator and the automatic control of the combustion air from the automatic totalizing fuel system, and set manually any desired constant air flow.

The combustion-air totalizing relay is not only used to provide the correct air for the two fuels, or either fuel, but is also used in conjunction with the Btu-input unit, as a decrease in the total fuel will result in the proper change in the combustion air. This would not occur if the air regulator were set on a constant air flow. It would then be necessary for the operator to reduce the total air by means of the hand wheel provided on the panel for this purpose.

Since it is probable that in the operation of the open hearth furnace, only one gas (coke oven or natural) will be used at any time the addition of natural gas to the above control can be accomplished by the addition of a gas selector valve, an additional gas regulator, and additional elements on the fuel splitter and air totalizer as shown in Figure 7.

While furnace reversal is not under discussion, the necessary equipment to either reduce air loadings and flows or lock regulators in position can be included, and usually are. In this way the furnace and checkers are purged of flue gas before fuel is again added.

In all these open hearth examples, it has been assumed that the Btu input is set manually and that either fuel-air ratio or constant air is used. If desired, the Btu input may be controlled directly from furnace or roof temperature. Another arrangement could be the control of total air up to maximum by roof temperature and control of total fuel from oxygen content of the combustion products. This would automatically adjust for bath reactions, which is not accomplished by either fuel-air ratio or constant air. Figure 8 illustrates such a system.

The controls for reheating furnaces are essentially the same as those for open hearth furnaces, with the elimination of reversal equipment. While the controls would be set up to handle several fuels, as in Figure 7, the operation normally would be one of changing completely from one fuel to another by the use of a transfer valve or a gas-oil ratio valve as conditions require.

Either furnace temperature or steel temperature may be used as the master control which determines the required total Btu input. Figure 9 shows a system set up in this manner. For multiple-zone furnaces a similar control would be set up for each zone.

In conclusion, the purpose of multi-fuel controls is to obtain the maximum economic gain from fluctuations in fuel costs. Natural gas will be available at low cost, but will probably be seasonal in supply with possible short cut-off notice. Considerable savings are possible if boilers and furnaces are equipped to use the most economical fuel when it is available, and other fuels when necessary. Maximum saving can only be attained with multi-fuel controls. Suitable controls for multi-fuel firing are available for simple and rapid change from one fuel to another or for combination firing as required.

Alan Wood STEEL COMPANY

Alan Wood STEEL COMPANY

. . . . celebrating its 125th anniversary, the Alan Wood Steel Co., though not a giant of the industry, can look with pride at its history of development, and with confidence to its future . . . .

BY T. J. ESS

▲ FOR the past 125 years the name of Alan Wood has been associated with the iron and steel industry of the United States. The present company traces its origin back to 1826, when James Wood, who had been operating various forges since 1792, and his son Alan leased what was known as the Delaware Rolling Mill, on Red Clay Creek near Wilmington, Del. This mill rolled a considerable quantity of what was called shovel or saw iron from purchased slabs or bars.

Some five years later, the business, including equipment and workmen, was moved to Conshohocken, Pa., where sheets were rolled in an 18 × 36-in. sheet mill stand coupled directly to the shaft of a water wheel 16 ft in diameter and 20 ft long, turned by the Schuylkill River. It is interesting to note that this mill produced 54 sheets, 36 in. long, in 12 hours. In subsequent years, various improvements were made to plant equipment, and new processes and methods were adopted. Steam power replaced the old water wheel in 1851, and eleven years later, a puddling furnace, a bar mill and another sheet mill were installed.

In 1857 Alan Wood and Co. was formed by Alan Wood and Lewis Lukens, and the Schuylkill Iron Works was started adjacent to the original James Wood & Son plant.

The manufacture of iron and the rolling of sheet and bar continued under various corporate identities until 1903, when the production of steel began in the Ivy Rock plant of Alan Wood Iron and Steel Co. This plant consisted of five 55-ton open hearth furnaces and a 35-in. steam driven blooming mill. More furnaces were subsequently added, and in 1911 the company absorbed the Swedeland blast furnace plant, directly across the river. This plant had been built in 1849, and had been owned and operated by Richard Heckscher & Sons. A plate mill was installed in 1914.

In 1918 a coke plant was built, just north of the blast furnaces, by the Rainey-Wood Co. This plant became a unit of the steel company in 1929, when a complete reorganization took place and the present company name came into being.

Over the years, facilities for producing and rolling steel have been expanded. The principal addition in recent years is a 30-in. hot strip mill which was placed in operation at the start of 1950. This unit has given Alan Wood Steel Co. greatly expanded capacity for the production of finished material, and particularly, for flat-rolled products. Prior to this installation, the company's primary producing capacity exceeded the capacity of its finishing mills, necessitating the sale of a considerable portion of its production in semi-finished forms.

The pioneering enterprise covered so briefly in the foregoing has resulted in the integrated facilities now lying along both sides of the Schuylkill River and centering about Conshohocken. The company now includes plants for the production of 600,000 net tons of by-product coke, 454,800 net tons of pig iron, and 625,000 net tons of steel ingots per year. Rolled steel products include blooms, billets, slabs, sheared plate, rolled steel floor plate, hot rolled strip, and stainless clad plates and sheets. During the past decade, greater

emphasis has been placed on the development of specialties, a plan by which many small producers have thrived in competition with the giants of industry.

As might be expected with an organization whose roots extend back for more than a century, the Alan Wood Steel Co. enjoys an unusually harmonious relationship with its community and its employees. This is due to persistent effort on the part of the company to cultivate and improve these relations, and to resident ownership by the Wood family, which still plays an important role in the affairs of the company. A liberal pension plan, together with various other employee welfare benefits, have built up some remarkable service records, and the common interest of company, employees and community has become a tradition.

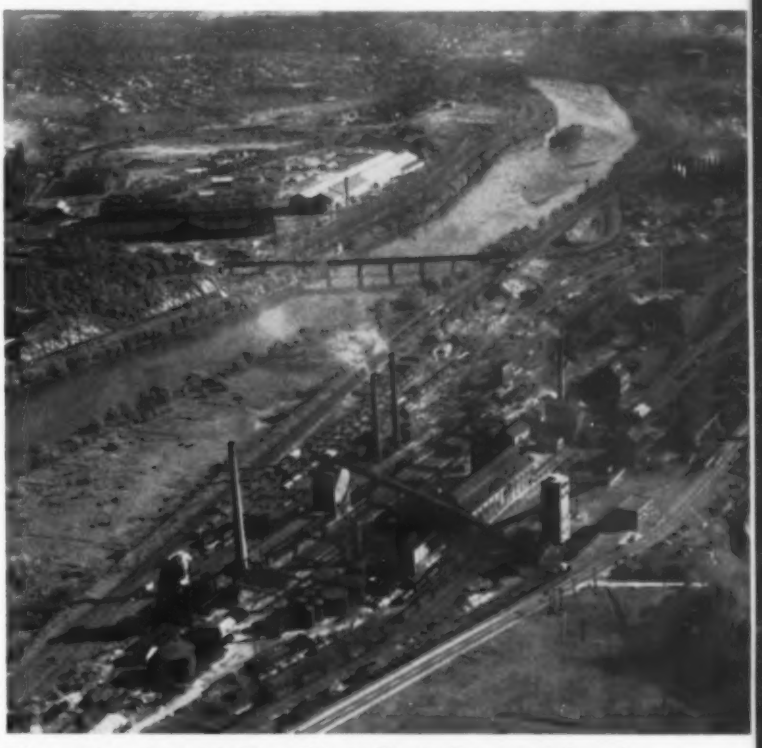
COKE PLANT

All coal is purchased from mines in Pennsylvania and West Virginia, and arrives by rail. It is unloaded by a rotary car dumper into track hoppers, from where conveyors take it to the breaker building. Here the coal is processed at a rate of 250 tons per hr through a breaker, and then passes into mixing bins from which the desired proportions of high and low volatile coals are blended. The coal then goes to a hammer mill for pulverization and then to storage bins over the oven batteries. The proportions used in this plant are about 80 per cent high volatile coal and 20 per cent low volatile. Actually, two distinct mixtures are used, depending on whether furnace coke or foundry coke is to be produced. Average analyses of these coal mixes are shown in table.

Two four-hopper charging larries move the coal from the storage bins to the ovens. No scales are provided on these larries, the measurement being made by volume.

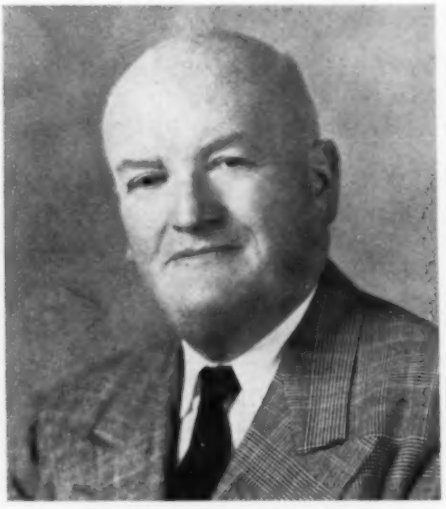
Coking capacity of 2500 tons of coal per day is provided by 151 by-product ovens arranged in three batteries. Two batteries each contain 55 cross-regen-

	For furnace coke	For foundry coke
Moisture, per cent	4.4	5.1
Volatile matter, per cent	29.0	23.7
Fixed carbon, per cent	62.8	70.2
Ash, per cent	8.2	6.1
Sulphur, per cent	1.14	0.78
Pulverization, per cent through $\frac{1}{8}$ in. screen	67.8	75.1
Density, lb per cu ft	45.8	43.1



The main plant of Alan Wood Steel Co. straddles the Schuylkill River. The coke plant is shown in the foreground, with blast furnaces at upper right and steel plant at upper left. A hot-metal bridge spans the river.

JOHN T. WHITING
PRESIDENT



PERRY L. FRANCIS
VICE PRESIDENT IN CHARGE OF SALES

CHESTER L. DAVIS
EXECUTIVE VICE PRESIDENT

Coking capacity for 2500 tons of coal per day is provided by 151 by-product ovens arranged in three batteries.

erative ovens with vertical heating flues in each wall connecting into a single horizontal flue. Gases that heat the oven flow upward in the flues in one-half of the oven wall, through the horizontal flue, and down through the flues in the other half of the wall, the direction of flow being reversed regularly by an automatic timing mechanism. These ovens are 38 ft long, 9 ft 10 in. high and 15¾-18¼ in. wide, and are heated with coke oven gas.

The third battery consists of 41 ovens, also heated by vertical flues, but with the flue system designed so that the gases from several vertical flues in one wall are gathered into a short horizontal flue and led through a cross-over flue of inverted U-shape over the top of every other oven and down through several vertical flues in the opposite wall. The direction of flow is also reversed regularly. These ovens are 38 ft long, 9 ft 10 in. high and 16¼-17¾ in. wide, and may be heated with coke oven gas or with coke producer gas. The latter is made in three 60-ton producers, each equipped with a waste heat boiler. This gas runs about 125 Btu per cu ft, and is also mixed with the coke oven gas, which averages about 550 Btu per cu ft, to maintain a constant heating value of 530 Btu per cu ft for the final mixture. The producers can turn out 20,000,000 cu ft of gas per day, all of which is cleaned in an electrostatic precipitator.

The normal coal charge is 11.4 net tons of coal per oven. Furnace coke has a gross coking time of slightly less than 16 hr per oven. For foundry coke, the coking time may be as much as 35 hr. Normal furnace coke temperature when pushed from ovens is approximately 2000 F, which requires an average flue temperature of 2350 F. Waste gases leaving the regenerators of the ovens come to the battery stacks at 550-600 F.

Each battery is served by a door machine on the coke side of the battery, while two combination pushing and leveling machines serve all three batteries. Coke discharged from an oven is received in either of two quenching cars which are drawn by electric locomotive, and is then taken to the quenching station. These various movements are coordinated by an interesting frequency modulated communication system. Quenched coke is spread on a coke wharf to cool and then conveyed to a screening station where it is passed over grizzly screens. A crusher is used to break up over-size coke. Coke over 2½ in. is used for metallurgical purposes, and may be further sized to 3 × 5 in. Coke under 2½ in. is graded into egg, stove, nut, range and pea sizes. For the blast furnaces, coke is sized to 3 × 1¼ in. Screening capacity is 120 tons per hr on metallurgical sizes and 110 tons per hr on domestic sizes.

Coke for the blast furnaces is taken to the high-line stock bins in standard railroad hopper cars.

Scrub Oaks mine, at Dover, N. J., produces a mixture of magnetite and hematite averaging about 28 per cent iron content.

Equipment is provided for recovery of the usual by-products. Gas is removed from the oven batteries and pulled through four indirect primary coolers by two centrifugal exhausters, each capable of handling 26,000,000 cu ft of gas per day.

Tar extractors at the exits of the exhausters remove tar that may remain in the gas, while four decanters are installed to separate the ammonia liquor from the tar previously condensed out of the gas.

The gas is then bubbled through a weak sulphuric acid solution in either of two saturators. Ammonium sulphate crystals forming in the bottom of the saturator are removed and dried. Pyridine is also recovered from the solution in the saturator.

From the saturator, the coke oven gas flows through a tower type final cooler, where naphthalene is condensed out, and then through two light oil scrubbing towers. After by-products have been removed, 36-38 per cent of the gas is used to heat the ovens, and the remaining surplus is used in the steel works and by a

utility company. Three gas boosters, one rated at 24,000,000 cu ft per day and two at 15,000,000 cu ft per day, handle this surplus.

Wash oil from the scrubbers is put through two stripping stills, where light oil is removed. This light oil is charged into a batch type crude still to be separated into crude benzol, toluol, xylol and solvents. An agitator is provided wherein these crude fractions, except solvents, are washed with sulphuric acid and then a caustic soda solution to remove paraffins, unsaturated hydrocarbons and other impurities. The crude fractions are then processed in a batch type pure still to obtain refined products.

Coke and by-product yields average as follows:

	Per ton of coal coked
Coke (furnace and domestic), lb	1450
Coke breeze, lb	100
Coke oven gas, cu ft	10,450
Tar, gal	7.5
Ammonium sulphate, lb	21
Light oils, gal	2.0

BLAST FURNACES

Iron ore is supplied principally by two company-owned underground mines in New Jersey, the Washington mine at Oxford and the Scrub Oaks mine at Dover, but some foreign and Lake ores are also purchased. The Washington mine, using bench mining methods, produces a magnetite which in its crude state contains 40 per cent iron. This ore is crushed and concentrated at a rate of about 90 tons per hr, using wet and dry magnetic separation. At Scrub Oaks, mining is principally by shrinkage method, and the ore is a mixture of magnetite and hematite averaging about 28 per cent iron content. The crude ore is concentrated by wet magnetic and gravity processes with a capacity of 220 tons per hr. The mines have a combined production of about 400,000 tons of concentrates per year.

The mining operations give some by-products of considerable value, including stone, sand and grit for poultry feed.

The concentrates from these two mines will pass through a $\frac{3}{8}$ in. screen, and show analyses averaging as follows:

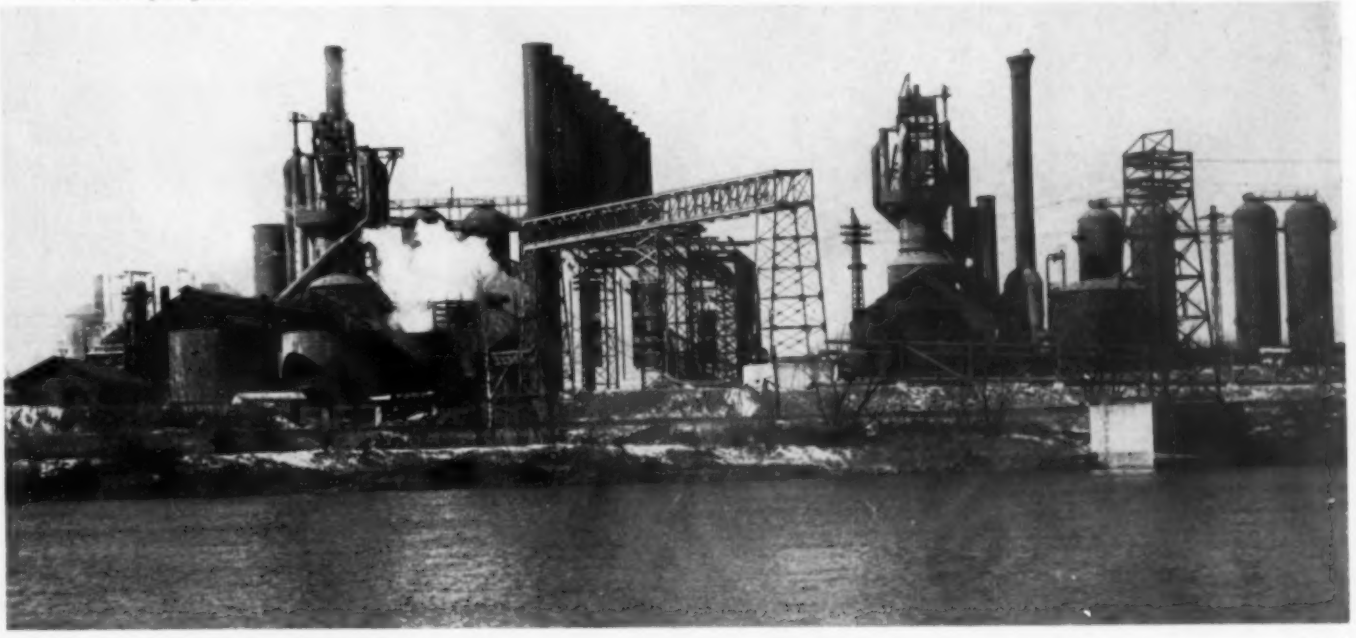
	Per cent	
	Washington	Scrub Oaks
Fe	58.0	65.5
Mn	0.22	0.04
P	0.305	0.02
S	1.12	0.015
SiO_2	8.5	5.5
Al_2O_3	2.75	1.0
CaO	1.5	0.6
MgO	0.75	0.35
Moisture	2.0	4.0

Concentrates are shipped to the furnace plant by rail, where they are loaded by a traveling car dumper into concrete receiving bins. The concentrates, together with the dust and sludge from the blast furnace gas cleaning system and some hard coal fines, are fed in the proportions desired from the bins to a conveyor belt by feeder belts. The conveyor belt carries the mixture to storage bins above each sintering machine, from where the material passes through a pug mill and down through a swinging feed spout on to the grates of the sintering machines, and is leveled into a 10-12 in. bed. Ignition is supplied by a coke oven gas flame that impinges on the bed of material on the grate. The mixture is processed in three traveling grate sintering machines, each 42 in. wide × 66 ft 6 in. total length. Each machine has six windboxes connected to a 100-in. fan which provides a suction of 15-22 in. water column.

The capacities of the three sintering machines total 1400-1500 tons per day.

At the discharge end of the machines, the sinter drops into a pit and is sprayed with water. The pit is

Two blast furnaces, with hearth diameters of 14 ft 9 in. and 18 ft respectively, provide capacity for 454,800 net tons of iron per year.



The ore yard, 1200 ft long x 220 ft wide, provides storage for about 1,000,000 tons of ore, and is served by traveling car dumper and ore bridge.

emptied by the ore bridge and the sinter is placed either into the blast furnace bins or in a section of the ore yard.

Purchased ores are unloaded directly into the ore yard, which is 1200 ft long × 220 ft wide and provides storage for approximately 1,000,000 tons of ore. The yard is served by a 7½-ton bridge of 240-ft span, with a transfer car running along the furnace high line over the furnace stock bins.

Limestone is purchased from nearby sources and is usually unloaded directly into the furnace stock bins, although it may also be handled through the ore yard if necessary.

Iron is produced in two blast furnaces, dimensional proportions for which are given in Table I. In both furnaces, the hearth is cooled by cast iron hearth jackets. Copper cooling plates are used in the bosh and extend up into the inwall 30 ft above the mantle. Stock lines are protected by cast steel wearing plates set in reinforced concrete.

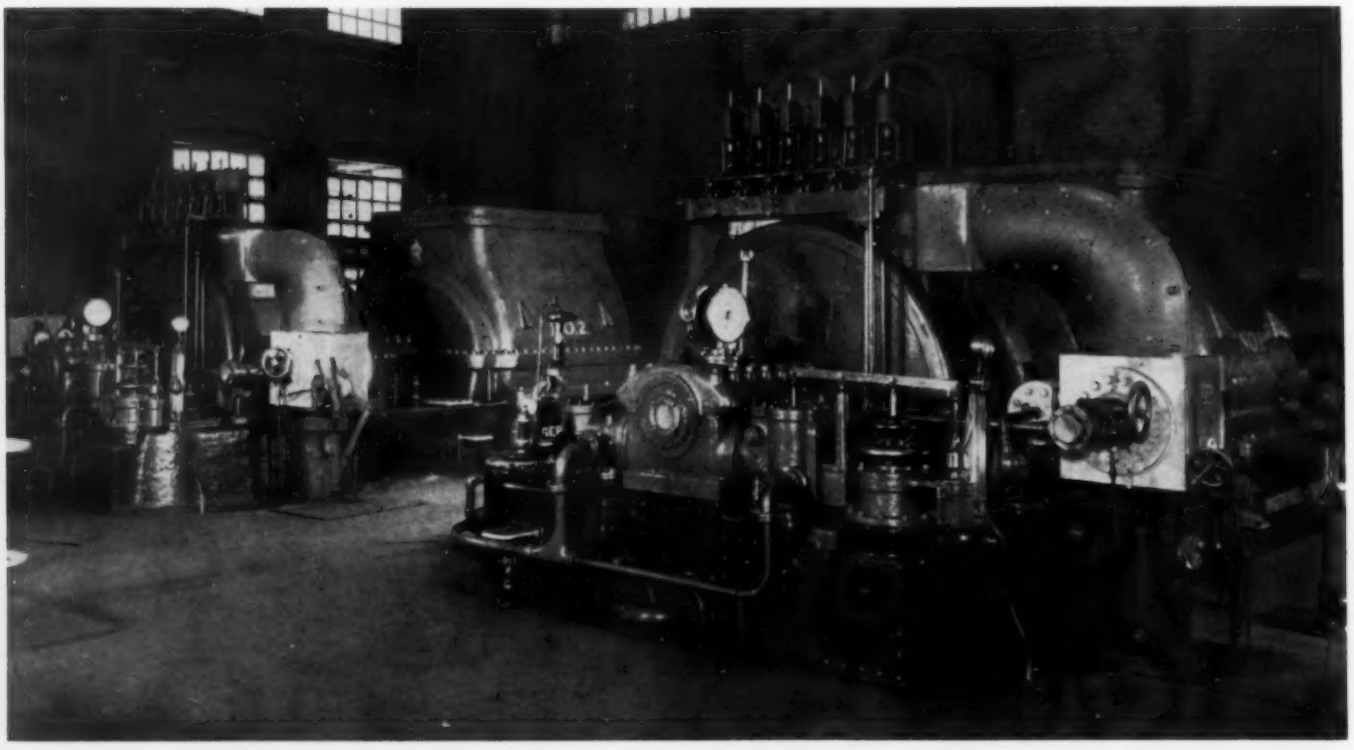
Each furnace is charged by a steam-driven, double skip hoist with 146 cu ft skip cars dumping into a

TABLE I

Blast Furnace Proportions

	Furnace number	
	2	3
Diameter of hearth, ft-in.	14–9	18–0
Diameter of bosh, ft-in.	19–9	21–10
Diameter of stockline, ft-in.	15–0	18–0
Height of crucible, ft-in.	8–5	7–5
Height of bosh, ft-in.	11–2¾	10–7
Height of straight section, ft-in.	6–1½	8–9
Height of inwall section, ft-in.	43–1⅞	39–5
Height of stockline section, ft-in.	6–8	8–10½
Height, iron notch to top ring, ft-in.	85–5½	85–10½
Height, bottom to iron notch, ft-in.	3–2½	2–11
Height, iron notch to cinder notch, ft-in.	4–0	3–8
Height, cinder notch to tuyeres, ft-in.	3–6	3–6
Bosh angle, deg-min	78–3	80–0
Inwall batter, in. per ft	0.66	0.58
Stack volume, cu ft	16,204	20,858
Number of tuyeres	12	12
Number of columns	6	6
Diameter of large bell, ft-in.	11–0	13–0
Thickness of crucible lining, in.	27	34¼
Thickness of bosh lining, in.	22	27
Thickness of stack lining, in.	42–27	42–36
Thickness of throat lining, in.	28	36
No. of hot blast stoves	4	4
Height of stoves, ft-in.	99–2¼	110–0
Diameter of stoves, ft-in.	18–5½	24–0
Heating surface per stove, sq ft	73,300	97,070

Two condensing turbo blowers, rated at 50,000 cfm, 30-psi pressure, provide blast for the two blast furnaces.



rotating distributor top. Bells are dumped by manually operated oil-hydraulic cylinders located on the furnace tops. The usual charging sequence on No. 2 furnace is OOSC/OSC/OCC/, while No. 3 uses OOSCC/. Coke is charged by volume, while ore and stone are charged by weight.

Blast is supplied to the furnaces by two condensing turbo blowers, each rated at 50,000 cfm, 30 psi pressure. Two old vertical steam blowing engines remain as standbys. Blast volumes average 30,000 cfm on No. 2 furnace and 37,000 cfm on No. 3. The blast is heated to 1100-1200 F in hot blast stoves as given in Table I. Checker work in the stoves is of basket weave construction, with 4½ in. flues. Stove cycle is two hours on blast, six hours on gas. Approximately 30 per cent of the total gas from the blast furnaces is used in the stoves. This gas and the air for its combustion are automatically proportioned by pressure type stove burners. Stack temperature of the stoves averages 500 F.

Blast pressure at the tuyeres ranges 15-18 psi. Top pressure averages about 25 in. water column. Furnace top temperature runs about 350 F. Gas leaves the furnace through four off-takes which combine into two downcomers.

Blast furnace gas leaving the furnace normally contains an average of 9.4 grains of dust per cu ft. Passing through a primary dust catcher and four small secondary whirlers reduces this to 2.15 grains per cu ft. All of the gas then goes through a wet tower washer, which further reduces dust content to 0.15 grains per cu ft. Gas for heating the stoves is taken off at this point, while the surplus is passed through a double-chamber electrical precipitator containing 352 tubes, 8 in. in diameter and 15 ft long. A prong type electrode runs through the center of each tube and carries an electrical charge at 75,000 volts which repels dust particles and causes them to cling to the inside walls of the tube. A constant flow of water washes the tube surface, carrying dust out of the bottom of the precipitator. Leaving the precipitator with a dust content of about 0.005 grains per cu ft, the surplus gas is used for boiler fuel.

Effluent from the tower washer and from the precipitator flows to a double tray thickener, 42 ft in diameter and 14 ft deep, with a capacity of 1,400,000 gal per day. Here, dust settles out while water is decanted off the top. The sludge is pumped out on to piles and allowed to drain off.

Flue dust from the dust catchers and whirlers and sludge from the thickener are taken to the sintering plant, as previously mentioned, for processing with the magnetic concentrates.

Iron is produced for use in the open hearth furnaces and for sale as merchant iron. No. 3 furnace is usually kept on basic iron and produces an average of 815 net tons per day. Both basic and foundry iron is made in No. 2 furnace, which averages 600 tons per day on the basic grade and 450 tons per day on foundry iron. Typical iron for use in the open hearth contains about 0.90 per cent silicon, 0.95 per cent manganese, 0.037 per cent sulphur, and 0.28 per cent phosphorus. Merchant iron is produced in standard analyses as desired by customers.

The furnaces are cast every 4 hr, iron being tapped into 125-ton mixer type ladles from No. 3 furnace, and into 40-ton open top ladles from No. 2 furnace. The ladles of hot metal are transported to the steel plant across the river over a heavy structural steel bridge which also carries steam and coke oven gas pipe lines.

Annual steel-making capacity of 625,000 net tons of ingots is provided by eight 125-ton open hearth furnaces.

Iron not to be used as hot metal in the open hearth, which runs about 35 per cent of total production, is put over two double-strand pig machines capable of handling 1400 tons of iron per day.

The high iron content of the sinter charged to the furnaces results in coke rates that are remarkably low for small furnaces, running about 1430 lb per net ton of basic iron and down to 1350 lb per ton, if about 10 per cent scrap is added to the charge. The coke rate for foundry grades runs about 1950 lb per net ton of iron.

Slag, which averages about 720 lb per ton of iron, is handled in either of two ways. It may be poured over a dump, allowed to cool, and subsequently dug up, crushed and graded for the usual construction and road building purposes; or it may be taken in its molten state to another plant where water granulates and expands it into a light weight product. Both of these slag processes are carried on by outside companies.

Modern soaking pits, fired with fuel oil or coke oven gas, are arranged in six blocks of two holes each.

OPEN HEARTH

Steel-making facilities consist of eight 125-ton basic open hearth furnaces, with hearth 40 ft 6 in. long × 14 ft 2 in. wide. The hearths are constructed with a minimum of 16 in. of basic brick backed up by clay brick to approximate the desired contour of the bottoms. About 6 in. of basic plastic refractory is then rammed in and topped with approximately 8 in. of magnesite, burned in. End walls, front walls and back walls are of basic brick. Sloping back walls are at present used on only two furnaces. Roofs are of silica brick, 12 in. thick, with an 18 in. panel 4 ft wide along the back skew. They are horizontal from end to end, with no knuckle over the furnace throat.

Downtakes provide a total area of 40-43 sq ft at each end of the furnace and lead into a single slag pocket approximately 12 × 14 ft. Regenerator chambers are about 22 ft long and are divided into two sections, approximately 12 and 8 ft wide, respectively, with suspended arch roofs. Checkerwork to a depth of 8 ft 3 in. above the rider arches is constructed of firebrick, 9 × 4½ × 3 in., with flues 7½ × 7½ in. A 3¼ in. layer of insulation covers the regenerator walls. This design results in a checker volume of 8725 cu ft at each end of the furnace. On several furnaces, this volume has been increased to 10,500 cu ft.

The furnaces are fired with fuel oil through steam-atomizing gun type burners. Oil is received by tank trucks or rail tank cars and unloaded by gravity and pumps into four storage tanks totaling 620,000 gal capacity. Automatically controlled oil heaters maintain temperatures of 190-200 F in the oil going to the furnaces from the circulating oil system. Tar and coke oven gas may also be used when available.

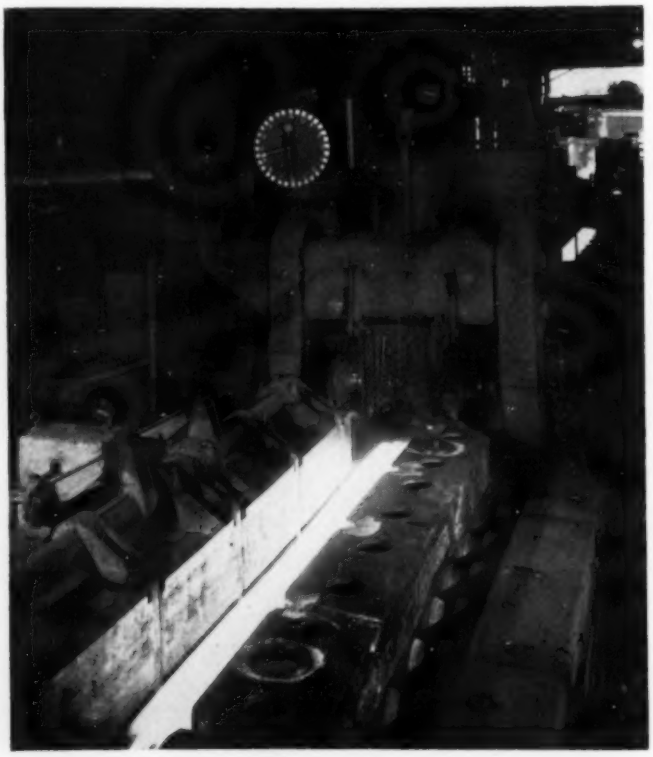
The furnaces have been equipped with reversal time signals, automatic control on oil flow, and recorders on oil flow, coke oven gas flow, furnace pressure and roof temperature. Two of the furnaces also have air flow recorders.

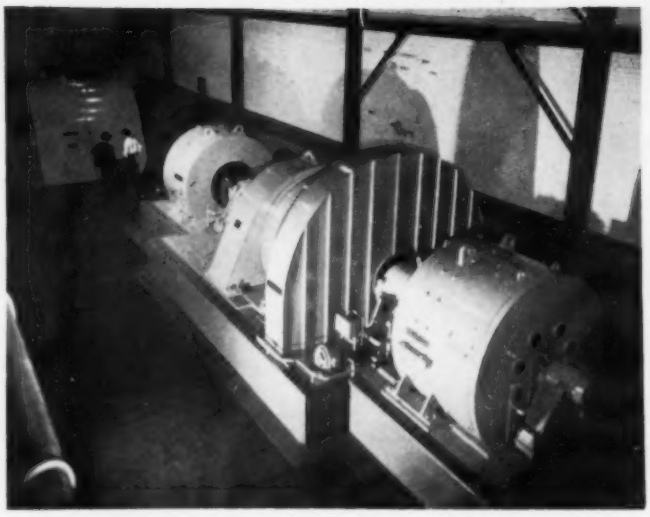
Three of the furnaces have water-tube waste heat boilers, each containing 5830 sq ft of heating surface and operating at 135 psi. Waste gases from the open hearth furnaces come to the boilers at 1050-1200 F and leave at 450-500 F. Steam production averages about 13,500 lb per hr per boiler.

A furnace design developed in the company is now being tested and, if successful, will probably serve as the prototype for complete modernization of the open hearth shop, with increased capacity.

Furnace charges, totaling about 276,000 lb, usually consist of about 49 per cent hot metal from the blast furnace and the remainder of No. 1 and 2 scrap, bundles and turnings. The flux charged is the equivalent of 8.5 per cent of limestone. Time of heat averages 9.56 hr, charge to tap, and 10.42 hr, tap to tap. Furnace production averages 12.9 tons per hr, charge to tap, and 11.8 tons per hr, tap to tap. A traveling dolomite gun

This 35-in. blooming mill, originally steam-driven, is now driven by a 3500-hp, 50 to 120-rpm, 700-v d-c reversing motor.





The blooming mill motor, shown in the background, receives power from this 3000-kw motor-generator set.

Slow cooling of certain grades of steel rolled on the blooming mill is carried out in this insulated, unfired furnace with removable roof.

is used to maintain furnace bottoms and banks between heats.

Steel is produced in rimmed, semi-killed and killed types over a wide range of carbons and in some alloy grades. The finished heats are tapped into 125-ton ladles, then poured into a variety of ingot molds, including big-end-up types 21 × 21 in., 23 × 25 in. and 25⅜ in. round; and big-end-down types 10 × 24 in., 12 × 26-40 in., 17½ × 22½ in., 18 × 28 in., 20 × 20-28 in., and 25¼ × 28 in. Before use, ingot molds are cleaned and sprayed with a graphite wash. Approximately 55 per cent of the ingot production is bottom cast.

Open hearth slag, which runs about 320 lb per ton of steel produced, is poured over a dump, where approximately 75 per cent of it is broken up for use in the blast furnace burden.

The open hearth buildings consist principally of an unroofed stock yard 1040 ft × 70 ft; a lean-to 1040 ft × 25 ft 9 in.; a charging bay 1040 ft × 56 ft 6 in.; a pouring bay 1200 ft × 55 ft 2 in.; and a mold yard 566 ft × 81 ft 4 in. The stockyard is served by two 10-ton cranes, the charging bay by three 10-ton overhead chargers and one 70-ton hot metal crane, the pouring bay by three 150-ton ladle cranes and four 10-ton stiff-leg stripper cranes, and the mold yard by one 10-ton crane. There are also a 120 ft × 40 ft stripper runway carrying one 150-ton crane, a 210 ft × 81 ft 4 in. skull drop served by one 10-ton crane, and at one end of the charging bay, a hot metal building 140 ft × 66 ft with a 70-ton crane. There are also three outdoor scrap yards, each served by a 10-ton crane.

The open hearth department is served by both standard and narrow gage railroad.

BLOOMING MILL

Ingot heating facilities consist of six blocks of soaking pits of two holes each. One block is of regenerative design, with each hole 8 ft 9 in. wide × 12 ft 9 in. long × 8 ft 6 in. deep. The other five blocks are of recuperative design, each hole being 12 ft 9 in. wide × 15 ft long × 9 ft 6 in. deep. Each of these holes has a tile recuperator which heats air for combustion to about 1300 F, the air being drawn through the recuperator by a 230,000 cfhr fan. Oil or coke oven gas is introduced through a single burner at the center of the pit bottom, while waste gases are vented through a flue in each bottom corner of the pit. Waste gases leave the recuperator at about 800 F. Complete control equipment affords automatic regulation of furnace temperature, furnace pressure, and fuel-air ratio.

Heating time varies with the ingot size and its temperature when charged. Charging temperature averages about 1700 F, and fuel consumption, about 1,125,000 Btu per ton of ingots charged.

The soaking pits are arranged in a double row paralleling the blooming mill line. Ingots are handled into and out of the pits by a 15-ton stripper crane and two 7½-ton stiff leg pit cranes, all of 81 ft 4 in. span. The heated ingot is placed in an ingot buggy which conveys it to the blooming mill approach table. Pit covers are handled by two 28-ton gantry cover cranes.

The blooming mill is a 35-in., two-high reversing unit, driven through 15-in. spindles by a 3500-hp, 50-120-rpm, 700-v, d-c motor, which develops a torque of 1,010,000 ft-lb. Mill pinions, of 36-in. face, have double helical 20-degree involute cut teeth. They operate in babbitted bearings.

Mill rolls are of alloy steel, with bodies 6 ft 8⅞ in. long and 27-29¼ in. in diameter, carrying grooves of 4, 6, 9 and 12 in., and a 31½-in. bullhead. They run in composition roll neck bearings. The top roll is hydraulically balanced by a pressure of 575 psi, and is raised and lowered by 10-in. screws of 1½-in. pitch, driven by a single 75-hp, 515-1700-rpm, mill type motor under adjustable voltage control.

Ingots passing through the mill are manipulated by sideguards and fingers driven by 75-hp mill type motors, also under adjustable voltage control. Mill scale is handled by a hydraulic scale removal system.

Mill drive equipment is lubricated by a circulating oil system with 4200 gal storage capacity and a circulation rate of 150 gpm. Another system, of 3700 gal storage capacity and 75 gpm circulation rate, takes care of the mill drive motor and its motor-generator set. Two automatic grease systems and ten manual systems

serve the various mechanical auxiliaries of the mill.

Rolling speeds may range up to a maximum of 912 fpm, and the mill averages about 72 tons of ingots per hr. Product, which is about 90 per cent slabs and 10 per cent blooms, ranges 8-25½ in. in width and 1⅝-7 in. thick, with blooms from 4 × 4 in. up to 14 × 14 in. Reduction passes through the mill may run 15 to 29.

A motor room adjacent to the blooming mill houses the main mill drive motor, together with its auxiliary equipment, switch gear, controls, etc. Power is supplied to the motor from a motor-generator set consisting of two 1500-kw, 700-v, d-c generators driven at 514 rpm by a 3000-hp, 6900-v, wound rotor induction motor. This set also carries a 37⅓-ton laminated steel plate flywheel of 12 ft 9 in. diameter.

This motor-generator set, as well as the reversing motor driving the mill, are totally enclosed, and force ventilated by a down-draft system. Two fans deliver filtered outside air to the room, maintaining a positive pressure. Exhaust fans draw air down through the units and discharge the heated air through an outside stack located aside of the incoming fresh air stack. The two stacks are connected through dampers, so that the heated air discharge can be mixed with fresh incoming air ahead of the filter if temperature conditions make it desirable.

Also in the motor room is the motor-generator set that provides power for the adjustable voltage systems on screwdown and sideguard drives. This set is composed of three 75-kw, 250-v, d-c generators driven at 514 rpm by a 300-hp, 440-v synchronous motor.

The blooming mill drive was electrified in 1944, having previously been driven by a steam engine.

In line with the blooming mill and 178 ft 2 in. beyond is a steam-hydraulic shear capable of cutting up to 200 sq in. of hot steel. Sheared lengths are measured by a gage designed in the plant, and crop ends are pushed off the table into scrap boxes.

From the shear, the rolled material may follow various courses, depending on its ultimate destination. It may be kicked off into cradles and taken to an area in the blooming mill building, where facilities for hand and mechanical chipping are installed, or it may be taken to an adjoining slab yard that serves the plate mill, or it may proceed on over the mill tables and over a novel turn-table arrangement to the stocking area of the strip mill. Hand scarfing is used for surface conditioning in the plate and strip mill areas.

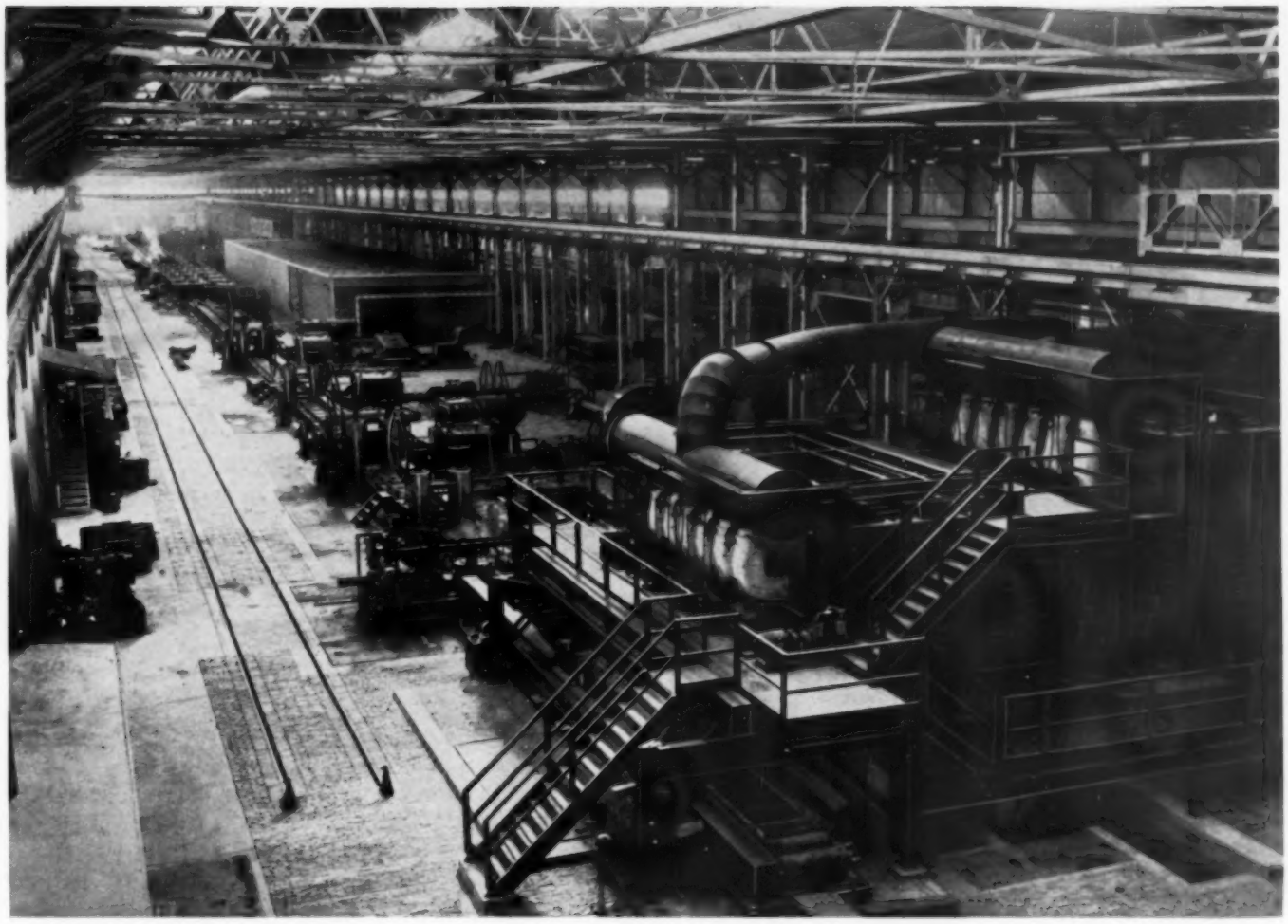
Near the blooming mill runout is a heavily insulated, unfired furnace with removable roof into which billets of certain alloy steels may be transferred for slow cooling. A water bosh is also provided for accelerated cooling of some low carbon products.

PLATE MILL

Sheared plate is rolled from slabs from the blooming mill or directly from bottom-poured ingots. Slabs and ingots are heated in six oil-fired, batch type furnaces. Four of these are regenerative, with hearths 27 ft 7 in. × 7 ft 9 in., while two are recuperative, with 35 ft × 7 ft 9 in. hearths. Automatic control has been applied to the recuperative units. Furnaces are arranged in two rows of three each, which parallel the mill line, one row

This mechanical chipping machine is one method employed in the careful surface conditioning given product from the blooming mill. Hand scarfing and hand chipping are also used.

Sheared plate, which represents an important item of Alan Wood's production, is rolled up to 72 in. wide and ⅜-1 in. thick on this 84-in. mill.



Alan Wood's 30-in. hot strip mill, put into operation early in 1950, has given the company greatly expanded capacity for flat-rolled products.

on each side of the mill. Steel is charged and drawn by two overhead rotating charging cranes, both rated at 4 tons. The heated steel is placed by the cranes on the mill approach table, which extends back between the two rows of furnaces.

The plate mill consists of two three-high, 84-in. stands, located 57 ft 2 in. apart. The first stand is used as a rougher, the second as a finisher. Top and bottom rolls are 30 in. in diameter, while middle rolls are 18 in. Babbitted bearings are used on the necks of the large rolls, while the middle rolls operate in bronze bearings. Forced feed lubrication is provided for all roll neck bearings.

Mill rolls are hydraulically balanced, and are adjusted by 10-in. diameter screws of 1¼-in. pitch, driven by a single mill type motor on each stand. Maximum roll lift is 13½ in.

Each mill stand is driven through 15-in. spindles and combination pinion and reduction gear units by a 2500-hp, 254-rpm, 6900-v, 60-cycle induction motor that develops a maximum torque of 80,000 lb ft. A 50-ton cast iron flywheel of 13 ft 6 in. diameter is mounted on each motor shaft. On the roughing stand, the gear unit sets up a reduction ratio of 3.95:1, giving a roll speed of 64 rpm or 500 fpm. The finishing stand operates at 71 rpm and 560 fpm through a gear reduction of 3.55:1.

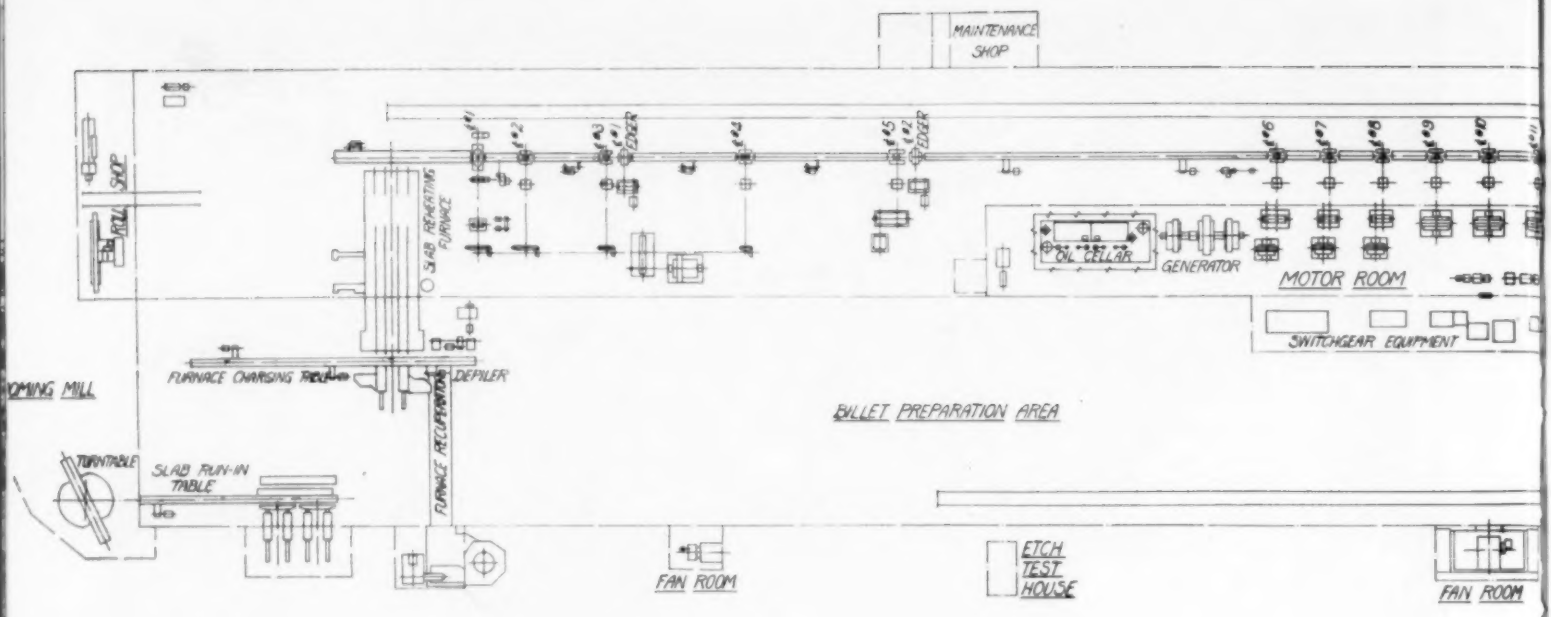
These main drive motors were originally 1600-hp, 2200-v, 25-cycle units, but in 1944 were rebuilt to their new rating, retaining without change the original shafts, bases and bearings. To improve the inherently low power factor of these slow speed motors, a bank of static capacitors is connected directly to the terminals of each motor. At the same time, the motors, which had been of open type, were provided with enclosing covers and chimney type frames for forced ventilation. Fans and a filter were installed, keeping the motor room under pressure and forcing air through the motors and into ducts through which the heated air can be discharged outside or recirculated, depending upon temperature conditions.

The mill produces sheared plate 70 to 72 in. maximum width in thicknesses of 3/16-1 in. at an average rolling rate of about 25 tons per hr, from slabs 18½-24 in. wide and 4-7 in. thick, or from ingots ranging from 10 × 24 in. up to 12 × 44 in. Approximately 18 passes are required to roll down slabs, and 25 passes on ingots.

Scale is removed from the steel passing through the mill through use of a grooved middle roll in the roughing stand and the use of salt in the finishing stand.

On each side of each mill stand is a tilting table, 23 ft 9 in. long, hydraulically balanced and actuated by a geared electric drive.

Approximately 90 ft beyond the finishing stand is a 90-in. hot roller leveler. Three other table lines, paralleling the mill runout table and interconnected by transfers and caster beds, provide time for the rolled



General layout of 30-in. continuous hot strip mill.

plate to cool. Three shearing units (96 in. end cut, 192 in. side cut) are installed in conjunction with the caster bed. Plates up to ¾ in. in thickness may be sheared. Heavier material is torch cut.

The final transfer and table line take the finished plate into an adjacent shipping bay.

STRIP MILL

The continuous hot strip mill is rated at an overall capacity of 240,000 tons per year, and is designed to produce hot-rolled strip over a range from 6 to 16 in. wide, 0.059 to 0.0746 in. thick, to 6 to 25 in. wide, 0.1196 to 0.25 in. thick.

Slabs, ranging 8 to 25½ in. in width, 66 to 180 in. in length, 3½-4¼ in. in thickness, and 900 to 5300 lb in weight come from the blooming mill and pass over the previously mentioned turntable and run-in table directly into the slab and billet preparation building, which also serves as a slab yard for the new strip mill.

From stock, cold slabs are brought by overhead crane to a magazine depiler which feeds them on to the furnace charging table. A double ram type pusher, permitting the charging of either one or two rows of slabs, moves them off the charging table and through the heating furnace.

At present, one heating furnace is installed, with provisions for the addition of a second unit when desired. The furnace is of the conventional three-zone continuous type, with a capacity of about 60 tons of slabs per hr. Its hearth is 18 ft wide, with lengths of 46 ft in the main heating zone and 14 ft in the soaking zone. The heating zone is supplied with six combination burners on top and six more on the bottom, while six burners overfire the soaking zone. Burners are designed to handle steam-atomized fuel oil or coke oven gas.

The furnace is steel encased, has a suspended roof, and is thoroughly insulated. Automatic control of temperature and fuel-air ratio is applied to each zone, and furnace pressure is also automatically controlled. All controls and instruments are installed in a control house located on the mill floor near the discharge end of the furnace.

An unusual feature of this furnace is the recuperator which consists of several long alloy steel tubes of large diameter placed in the flue between the furnace and its stack. A heating surface of 932 sq ft is thus provided. Air for combustion is pushed through the tubes by a fan rated at 18,480 cfm, 20 oz, and attains temperatures of 500-600 F.

Heated slabs are discharged from the furnace on to a mill approach table 39 ft long.

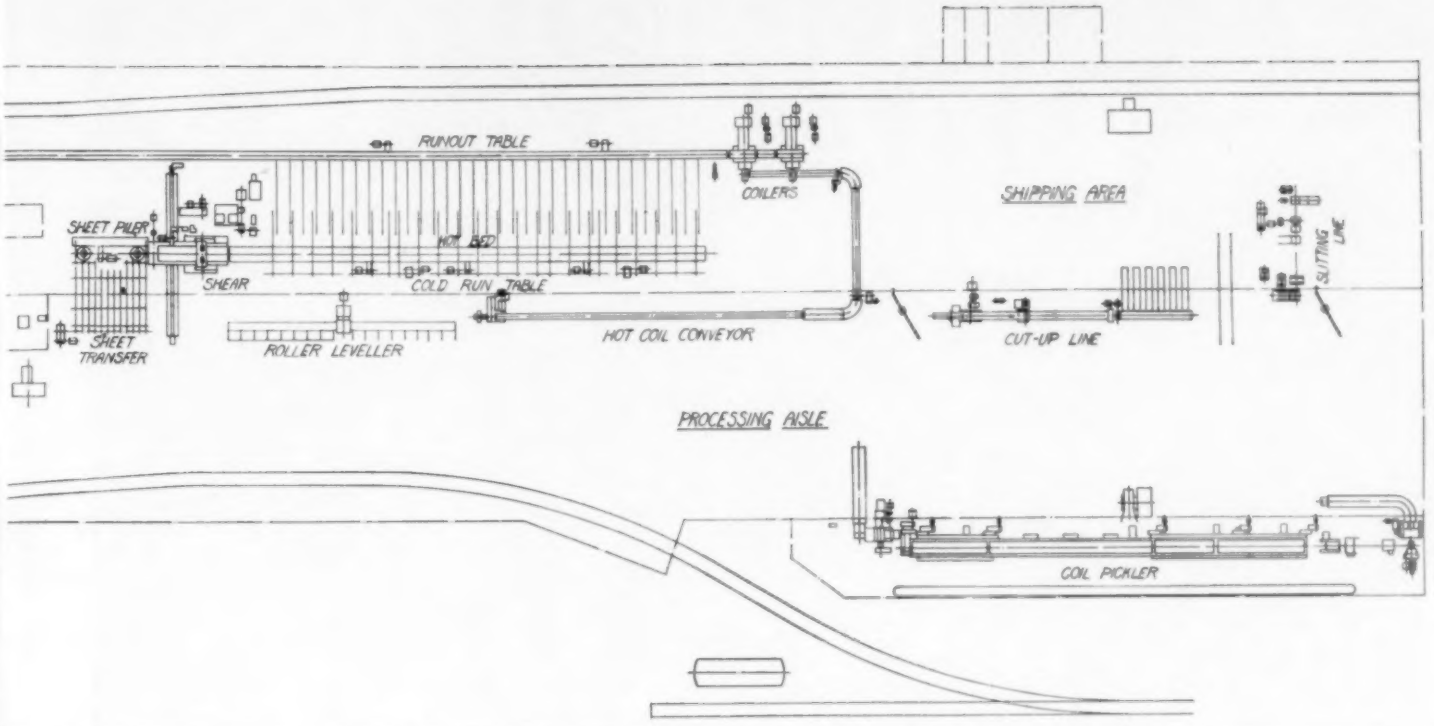
The first roughing stand of the 5-stand roughing mill is a vertical scale breaker with cast iron rolls 32 in. in diameter and 8½ in. long, running in roller bearings. No. 2, 3, 4 and 5 roughers are two-high, 20 in. × 30 in. stands spaced, respectively, 18 ft, 30 ft 6 in., 52 ft 6 in., and 57 ft from the preceding stand. Two vertical edgers, with rolls 19 in. in diameter and 10½ in. long, are installed, one, 7 ft behind No. 3 rougher and the second, 7 ft behind No. 5 rougher.

A delay table, approximately 136 ft long, separates the roughing train from the finishing train, which consists of six two-high, 21 in. × 30 in. stands, spaced on 20 ft centers.

Mill rolls are of steel in No. 2 and 3 roughers and in the two vertical edgers, and these stands are equipped with brass roll-neck bearings. Chilled iron rolls are used in No. 4 and 5 roughers and in the six finishing stands, with composition rollneck bearings. Roll settings are adjusted through manually operated screws.

A roll shop located at the end of the hot mill building contains a 42-in. roll lathe and a 24 × 96 in. roll grinder.

The first four units of the roughing train are driven through gearing by a single 1800-hp, 505-rpm, 6900-v wound rotor motor. Each of the small edging units is



driven by a 100-hp, 600 to 900-rpm, 250-v shunt motor. No. 5 rougher is driven by a 1500-hp, 662 to 772-rpm, 600-v d-c shunt motor.

The six finishing stands are individually driven by three 1500-hp, 280 to 420-rpm motors and three 1800-hp, 115 to 230-rpm motors, all of 600-v, shunt type.

Gear ratios and mill speeds are given in Table II.

Seven solenoid operated loopers are installed along the mill, two located on the delay table between the roughing and finishing trains, and five between successive stands of the finishing train.

As the steel passes through the hot mill, it is subjected at various points to steam jets and water sprays to insure a clean, smooth surface. These jets and sprays are controlled by solenoid operated valves. Water is supplied by a 1000-gpm, 1200-psi centrifugal pump.

Table rollers are of cast type, and in the tables between the mill stands are driven through line shaft and gears by d-c motors. The hot runout table, which extends approximately 290 ft beyond the end of the finishing train, is composed of 128 rollers, individually driven by fifty-three 0.2 to 0.4-hp motors and seventy-five 0.75 to 1.50-hp motors operating under variable frequency of 16.7 to 36.7 cycles.

At the end of the runout table are two down-coilers, each driven by a 50-hp shunt motor. From the coilers a hot coil conveyor extends into the adjacent processing building, making two 90-degree bends to double back in opposite direction to the mill flow.

Rolled product, not intended for coiling, is pushed off the runout table on to a cooling bed transfer approximately 162 ft wide × 32 ft long which leads to a cold run table. This table feeds a flying shear, designed to cut lengths of 5 to 40 ft of material up to ¼ in. thick. The shear is followed by a sheet piler and a sheet transfer over which product may be moved into the adjacent processing bay.

At present, equipment is provided only for hot finishing, and includes a roller leveling line for cut lengths, a combination leveling and cut-up line, a coil slitting line, and a coil pickler. The pickler contains a 23-ft hot water preheat tank, a 60-ft acid tank, a 23-ft cold water rinse tank and a 23-ft hot water wash tank, all constructed of reinforced concrete and brick. A 10 per cent

TABLE II

	Motor hp	Motor rpm	Gear ratio	Roll rpm	Strip speed fpm
No. 1 scalebreaker				12.4	104
No. 2 rougher				21.6	119
No. 3 rougher	1800	505	Various	35.1	193
No. 4 rougher				45.2	248
No. 1 edger (after No. 3 rougher)	100	600–900	13.78	43.6– 75.4	154–230
No. 5 rougher	1500	662–772	10.72	61.6– 71.8	339–396
No. 2 edger	100	600–900	7.44	10.5–121	284–427
No. 1 finisher	1500	280–420	6.53	42.8– 64.2	235–353
No. 2 finisher	1500	280–420	4.22	66.4– 99.7	365–548
No. 3 finisher	1500	280–420	3.4	87.4–123.4	453–679
No. 4 finisher	1800	110–230	Direct	100 –230	550–1264
No. 5 finisher	1800	115–230	Direct	115 –230	632–1264
No. 6 finisher	1800	115–230	Direct	115 –230	632–1264

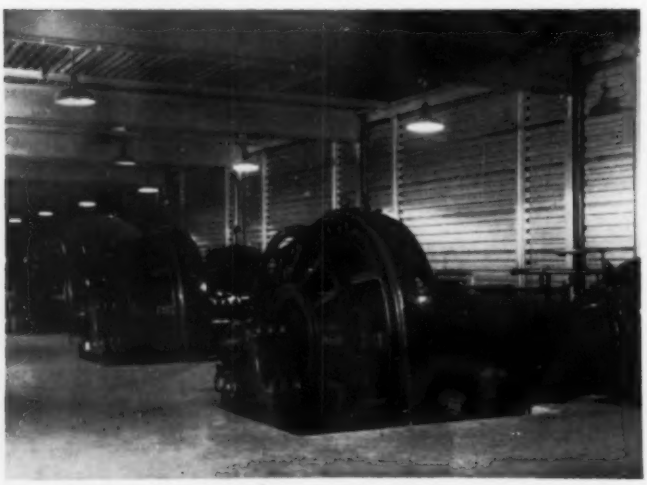
The finishing train, consisting of six 21 in. x 30 in. two-high stands, delivered strip at speeds of 632-1264 fpm.

solution of sulphuric acid at 180 F is used for pickling. Loosely wound coils are carried through the pickle line at a speed of 3 fpm, giving an output of 20 coils per hr. Cold finishing equipment may be another construction project for the future.

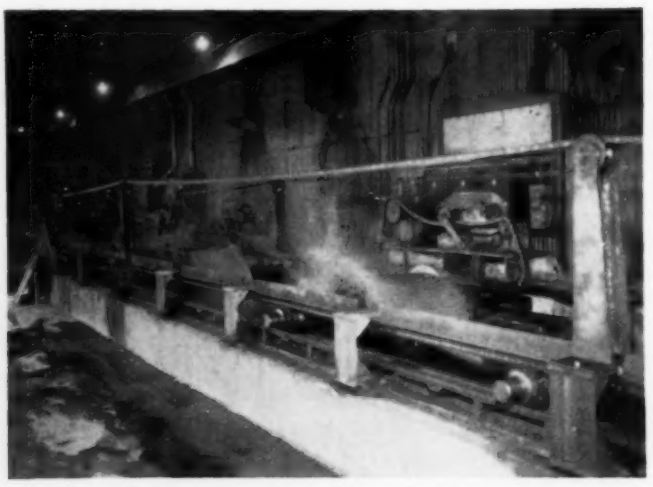
The strip mill motor room houses the six drive motors of the finishing train, together with their gear sets, motor-generator sets and all controls and switchgear. Power for the d-c drives which operate under adjustable voltage control is supplied by a motor-generator set composed of two 3000-kw, 650-v, d-c generators driven at 540 rpm by an 8400-hp, 6900-v synchronous motor. Excitation for these units and for the d-c mill drive motors comes from a set driven by a 300-hp, 440-v, 1800-rpm synchronous motor and containing a 100-kw generator for excitation of finishing stand drives, a 60-kw generator serving the 8400-hp synchronous motor fields, a 30-kw generator serving the 3000-kw generator fields, a 5-kw generator for the motor on No. 5 roughing stand, and another 5-kw generator serving control units. Two rotating regulator sets are provided for control of bus voltage and power factor. Variable frequency power for runout table motors comes from a set consisting of a 150-hp, 250-v, d-c shunt motor driving a 32-kva, 120 to 220-volt, 15 to 37.5-cycle a-c generator and a 100-kw, 56 to 120-v, d-c dynamic braking generator.

The large rotating equipment in the motor room is cooled by filtered forced air from a 130,000 cfm fan, keeping the motor room under pressure. The motors

Finishing stand drives, with their gear sets, motor-generator sets, control and switchgear are located in a motor-room which is kept under slight pressure by a forced draft ventilating system.



Loosely wound coils are carried through this pickling line at a speed of 3 fpm, the coils turning upon their supporting mandrels as they progress.



driving the roughing train are not located in the motor room, but are cooled by air from an 18,000 cfm fan.

Lubrication of the major units of equipment in the strip mill is effected through six circulating oil systems, five automatic grease systems and 21 manual grease systems.

The strip mill rolls at an average rate of 40 tons per hr, although it has produced as much as 75 tons per hr, 500 tons per 8-hr turn, and 1200 tons per day. Typical reductions in each mill stand is somewhat as follows:

Stand No.	Per cent reduction
2	40
3	40
4	38
5	32
6	40
7	38
8	32
9	28
10	20
11	10

Mill practice is about 92 per cent good product. Approximately 40 per cent of the strip mill product is shipped in coil form, 60 per cent in flat form.

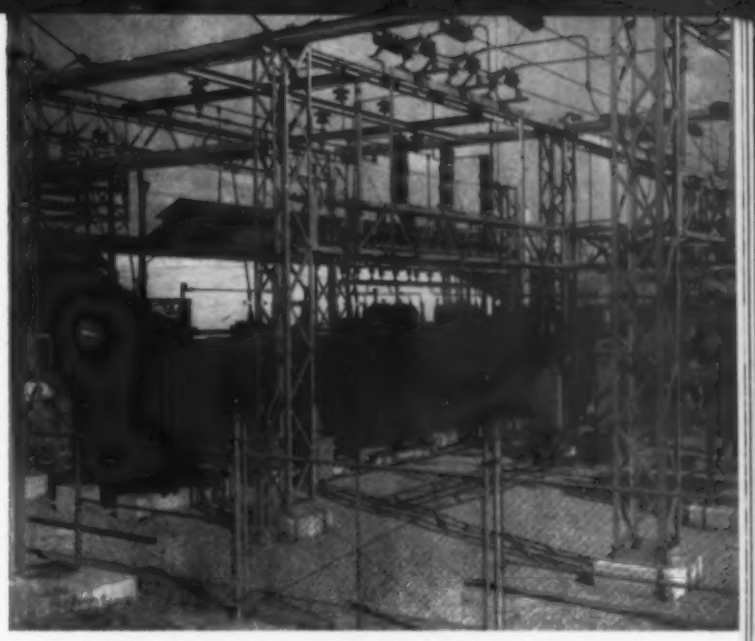
The strip mill is housed in two adjacent bays, each 85 ft wide × 1080 ft long. The rolling bay is served by one 25/10-ton crane and two 10-ton cranes. In the stocking and processing bay are two 10-ton cranes, two 15-ton cranes, a 7½-ton gantry which serves the slab preparation area, and a 15-ton crane used in stocking slabs.

PLANT SERVICES

Electric power is supplied from plant generation and from the public utility system supplying the district. Two 2300-v, 25-cycle, 80-per cent power factor turbo generators are installed in the powerhouse at the blast furnace plant, one rated at 5000 kva and one at 6250 kva, and both equipped with jet condensers. This power is used at the blast furnace plant in two 1000-kw motor-generator sets which provide 250-v d-c for the ore bridge, car dumper, pig machine, furnace auxiliaries and lighting, and is carried over two 600,000-cir mil circuits to the specialty division and over two more 600,000-cir mil circuits to the coke plant. Another 600,000-cir mil circuit runs across the river to the steel plant, where it serves a 1000-kw motor-generator set used as a standby or as an outlet for 25-cycle power when there is an excess of blast furnace gas. The 25-cycle system operates with a normal demand of about 5100 kw, and provides approximately 35 per cent of the entire plant consumption.

At the specialty division, the incoming 2300-v, 25-cycle power serves the three mill drive motors and two 500-kw motor-generator sets which supply 250-v, d-c power for cranes, tables, shears, etc.

The major portion of power requirements is taken care of by the 60-cycle purchased power system. This power enters the plant at 33,000 v over two circuits of 2-0 cable. Each circuit is provided with oil circuit breakers and a tie line breaker inter-connects the two circuits. Each circuit leads through an air-break switch to a bank of three 3333-kva, 33,000/6900-v transformers. One 6900-v circuit then runs to the blooming mill motor room, and the other to the strip mill motor room. From these two centers, power at 6900 v is distributed to main drive units, pumps and air compressors, to 6900/440-v transformers for auxiliary power, and to mercury arc rectifiers for d-c power. The 60-cycle system carries demands up to 11,000 kw, and supplies some 4,500,000 kwhr per month — about 65 per cent of the plant use.



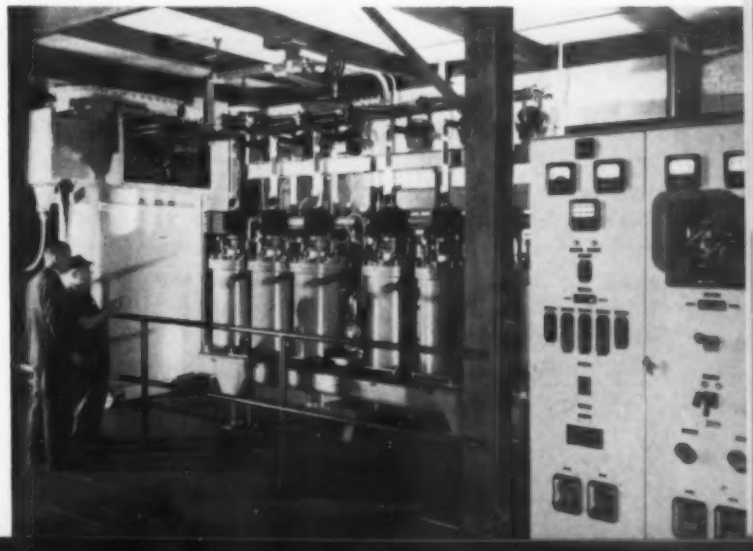
Incoming purchased power at 33,000 volts is stepped down to 6900 volts for plant distribution in this 20,000 kva outdoor substation.

There is also a 60-cycle tie-in to the coke plant which supplies an average of 840 kw for some 2300-v distribution. A 1000-kva frequency changer is connected between this 60-cycle tie and the 25-cycle system of the coke plant. D-c power for the coke plant is supplied from two motor-generator sets on the 25-cycle system.

Another 60-cycle tie at the specialty division brings in a small amount of purchased power for the stainless clad finishing department.

Some years ago the direct current system of the steel plant was revamped with the installation of two 1000-kw, 6900-v, 3-phase, 60-cycle mercury arc rectifiers, previously mentioned. These units took over the load previously handled by three 300-kw engine-driven

Three 1000-kw mercury arc rectifiers, placed in the principal load centers of the steel plant, provide most of the 250-v, d-c power for auxiliaries.



generators and two 1000-kw, 2300-v, 25-cycle motor-generator sets; one of the latter, however, was kept for standby service. The rectifiers were placed in the two principal load centers of the steel plant, one near the blooming mill and one at the open hearth. A third 1000-kw rectifier has since been installed at the strip mill.

Until two years ago, steam at the blast furnace plant was generated in ten 600-hp, 160-psi straight tube boilers, equipped to burn blast furnace gas with fuel oil or tar as standby. A recent addition to the steam producing facilities consists of two two-drum bent tube boilers designed to produce 125,000 lb of steam per hr at 610-psi pressure, 725-F total temperature. Each unit contains 18,440 sq ft of boiler surface, 3100 sq ft of water wall surface, 745 sq ft of superheater surface and 24,000 sq ft of air preheating surface. A combustion space of 10,000 cu ft is provided by the boiler setting. These units are fired through combination burners principally with blast furnace gas, but can also use coke oven gas when it is available, or as standby, fuel oil or tar. The combustion control system is designed for either blast furnace gas or coke oven gas as the primary fuel, with oil as the supplementary fuel. Virtually all operation has been with blast furnace gas, backed up with fuel oil.

In normal plant conditions, two blast furnaces are operating and these supply ample fuel for all steam requirements except during those periods when the blast volume is reduced. At such times, the combustion control system feels the reduction in gas pressure and reduces its use. At the same time the boiler is automatically fired with oil to supplement the decreased input of gas. Compensation is made automatically for the combustion air requirements of the varying proportions of the two fuels.

To handle the special condition when only one blast furnace is operating, it is usual that one boiler is fired with oil only, while the other boiler uses such blast furnace gas as is available, supplemented by additional oil as required.

Since the complete loss of blast furnace gas supply might result in air being pulled into the gas line, the combustion control system includes equipment to feel any abnormal decrease in blast furnace gas pressure and to close a rubber-lined valve in the gas supply line. This prevents a reverse flow of air.

The boilers attain operating efficiencies of about 80 per cent on blast furnace gas and 85 per cent on oil or tar.

Although these boilers are designed for 610-psi pressure, they are at present working at 165 psi in conjunction with previously existing equipment. They are the first step in an overall program involving the future installation of a 7500-kw extraction turbo generator. Installation of these boilers, with a 14-in. steam line about 4000 ft in length crossing the river and tying in to the steam system at the steel plant, eliminated twelve old 250-hp boilers. The only steam-producing facilities still operating at the steel plant are the three waste heat boilers at the open hearth, previously mentioned. The new line carries an average of about 50,000 lb of steam per hr to the steel plant.

At the coke plant, steam is produced in the three previously mentioned waste heat boilers on the gas producers, and in three 500-hp bent-tube boilers fired by coke breeze on chain grate stokers. Eventually it is planned to run a steam line between the coke plant steam system and the new boiler facilities at the blast furnace plant.

This new boilerhouse is the first step in an overall program involving the future installation of a 7500-kw extraction turbo generator.

At the specialty division, steam for miscellaneous heating and oil atomization is supplied from three 500-hp water tube boilers, two fired with fuel oil and one with powdered coal and tar.

The main plant water supply is, of course, the adjacent Schuylkill River, water being taken from the river through screens at several separate sources. At the blast furnace pump house are three 4500-gpm motor-driven centrifugal pumps that supply water to the blast furnace, coke plant and continuous softening plant. An 8500-gpm pump and a 4500-gpm pump, both steam driven, are also installed in the blast furnace powerhouse. The steel works pumphouse contains two 4000-gpm pumps and two 2100-gpm pumps, all motor driven. The specialty division is supplied from a pumphouse containing two 850-gpm motor driven pumps and a 1000-gpm steam driven unit. A recirculating water system, including three 1000-gpm pumps is being installed here. In addition to water from the blast furnace pumphouse, the coke plant also receives some from two 1950-gpm motor-driven units pumping from a nearby quarry pit.

The major portion of water for the steel plant now comes from an interesting installation, recently completed, combining a recirculating system with a treatment plant designed to eliminate or neutralize contaminating waste products from water discharged by the plant. The system removes iron oxide and oil in water from the rolling mills and neutralizes spent pickle liquor. Water from the mills flows into an oxide concentrator, two open concrete tanks 91 ft long × 16 ft wide × 9 ft deep, where most of the oxide and oil is removed by settling and skimming, respectively. Next the water flows through an aerating system, where make-up water from the river may be added if needed, and then to a clarifier 125 ft in diameter and 13 ft deep. Retention time in the clarifier is 35-40 min, and the

clarified water is run off into a clear well for reuse in the steel mill.

Waste pickle liquor is first neutralized with lime and then discharged with the sludge from the treatment system for the water from the mills.

Three 8500-gpm centrifugal pumps, (two driven by electric motors, one by steam turbine) pump the water out of the clear well into the plant system. Make-up water for the system (about 4000 gpm) is furnished from the river pumping station previously mentioned. The make-up water is screened at the intake by a continuous rotating screen. Sludge from the process is pumped from the sludge well into a nearby quarry pit.

Two smaller plants for the treatment of waste water were also installed, one at the coke and blast furnace plants and one at the specialty division.

The entire plant uses a total of approximately 750,000,000 gal of water per month.

Water from the river averages about 8.5 grains of hardness per gal. For feed to the new boilers, mentioned previously, this water is treated with lime and alum in a cold continuous process. Some of this treated water is used for washing down the tubes of the electric precipitator used to clean blast furnace gas, while the remainder passes through gravity filters to a storage well. Boiler feed is pumped from this well through three base-exchange sand softening units, and on to a deaerating heater. Because jet condensers are used on turbo generators and turbo blowers, and because much steam is sent across the river to the steel plant, make-up feed to the boilers at the blast furnace plant is approximately 90 per cent.

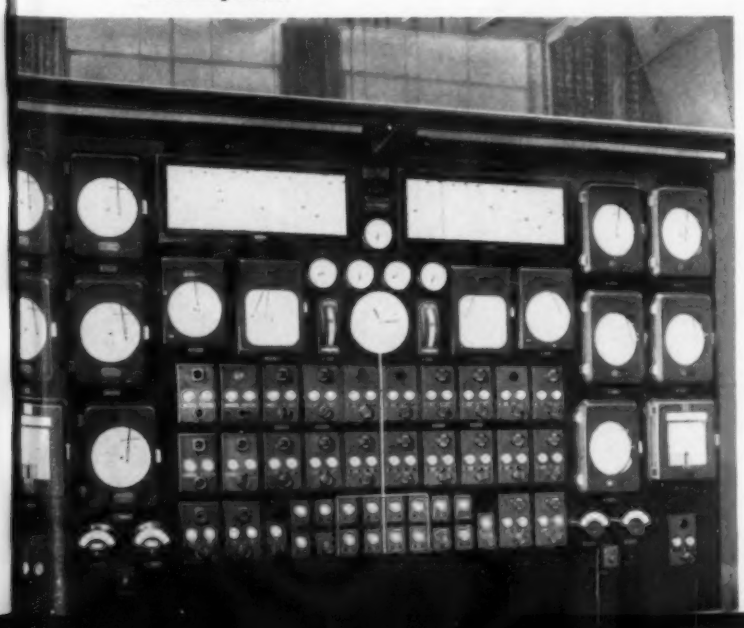
A base-exchange sand filter type softener is provided for boiler water at the coke plant, and another similar unit serves the waste heat boilers at the open hearth.

A full complement of shop facilities is available for repair and maintenance work, as well as some construction work. A large central shop houses a complete machine shop, forge and blacksmith shop, and welding shop. Nearby is an electrical repair shop and a locomotive repair shop.

The plant is served by both standard and narrow gage railroads, with steam and diesel power. The standard gage trackage is part of and links to the Upper Merion and Plymouth Railroad, which also serves other industries in the area.

To insure products of high quality that will meet customer specifications, laboratories are maintained for the control of raw materials and operations in the various steps in production processes. At the Scrub Oak mine is a chemical and physical laboratory which controls the concentration of ore and the sizing of ore, rock and sand. A pilot unit is also used to study ore concentration. There is a laboratory at the coke plant with complete facilities to analyze, chemically and physically, coal, coke and by-products, while a chemical laboratory at the blast furnace analyzes iron and slag. A chemical laboratory at the steel plant is the overall control laboratory for the mines, blast furnace and steel works.

A complete system of combustion control permits the new boilers to burn either blast furnace gas or coke oven gas as the primary fuel, with oil as a supplementary fuel.



SPECIALTY DIVISION

Occupying the plant of the old Schuylkill Iron Works is the specialty division, which includes jobbing mills, flat-rolled finishing facilities and a cut nail mill. There are five jobbing mills, details of which are as follows:

No. 1 mill — One two-high balanced rougher and one three-high finisher, 56 in. Served by one 8 ft × 37 ft pusher type slab heating furnace, oil fired. Driven at 48 rpm through gearing by a 1000-hp motor. Product is discharged through a 66 in. × 35-ft oil or coke oven gas fired continuous annealing furnace, then through a 60-in. roller leveler, over a transfer, through another 60-in. leveler, and over a cooling wheel and castor bed to a 144-in. shear.

No. 2 mill — One three-high, 48-in. finishing stand, driven at 48 rpm by the same motor that drives No. 1 mill. Served by a 5 ft × 39-ft continuous heating furnace, fired with oil or coke oven gas. Product passes through a 60-in. roller leveler and on to a 132-in. shear.

No. 3 mill — One two-high balanced rougher and one three-high finishing mill, both 72 in. wide and driven at 50 rpm through gearing by a 1200-hp motor. An 8 ft × 49-ft pusher type heating furnace, oil fired, serves this mill. Two 78 in. × 30-ft oil fired batch type annealing furnaces, an 80-in. roller leveler and two 132-in. shears are also provided.

No. 4 mill — One two-high, 60-in. finishing stand with automatic feeder and catcher tables. Served by one 70 in. × 50-ft continuous chain type double pack heating furnace, oil fired and equipped with automatic temperature control. Driven at 30 rpm through gearing by a 600-hp motor which also drives No. 5 mill. Product from No. 4 mill may pass on to a turn-table leading to a 66 in. × 40-ft oil or coke oven gas fired continuous annealing furnace, then through an 80-in. roller leveler and over a transfer and castor bed to a 144-in. shear.

No. 5 mill — One three-high, 72-in. finishing stand with automatic feeder and catcher tables. Served by one 10 ft × 50-ft continuous chain type single sheet heating furnace, oil-fired and equipped with automatic temperature control.

These mills produce hot rolled flat product of various carbon and alloy analyses in widths up to 60 in. and thicknesses from No. 18 gage to 3/16 in. They have a nominal capacity of 30,000 tons per year.

Finishing facilities in this plant are designed specific-

ally to handle the wide range of material produced in this division. For descaling and pickling, there are six tanks, side by side, served by a five-ton twin-hook overhead crane. One tank is used for caustic descaling, one contains a sulphuric acid solution, and another contains a nitric acid solution. There are also two water rinse tanks and one neutralizing tank. A scrubbing and drying unit completes the process. This pickle line handles stainless and stainless clad product, as well as carbon and alloy grades.

There is also one four-arm plunger mast pickler.

Annealing equipment in this department includes one portable furnace, fired with gas, with three bases, and one continuous roller hearth type furnace fired with oil or coke oven gas, also in radiant tubes. The continuous furnace is specially designed for annealing stainless-clad material, and operates over a wide speed range at temperatures up to 2150 F. At the exit end of this unit there is an air quench table, where air blast may be used to control cooling time. The material then passes through a roller leveler and over a castor bed to a 132-in. shear. A protective gas atmosphere is used in both of these annealing furnaces.

Cold rolling is performed on two 70-in. stands of two-high cold sheet mills driven at 35 rpm by a 300-hp motor.

Commercial finishes may be put on the stainless-clad material by two belt-type polishing machines. A spot grinder is also available for removing pits.

Miscellaneous auxiliaries include a stretcher leveler, various shearing equipment, a roll lathe and a roll grinder.

In the nail mill are 50 machines with a combined capacity for 4900 tons of cut nails, together with equipment for heat treating, galvanizing, bluing, polishing and kegging the product.

SPECIAL PRODUCTS

As previously mentioned, the trend at Alan Wood is more and more toward specialties. The company has long been a leading producer of floor plate, which it produces in several exclusive patterns. These products are made in widths up to 72 in. and thicknesses of $\frac{1}{8}$-$\frac{3}{4}$ in.

A new type of floor plate has recently been added, in which an abrasive is rolled into one side of the plate to a depth of about $\frac{1}{16}$ in. This material is made by building up a "sandwich" of two plates, separated by a spacer bar around the plate edges and a layer of a mixture of carborundum and iron grit. The "sandwich" is welded together around the entire perimeter, then heated and rolled as a unit in the plate mill or, for the lighter gages, in the jobbing mills. The plates are then sheared around the edges, and the two layers separated, giving two plates with one side so impregnated with the abrasive mixture as to provide a non-slip, hard-wearing surface. This product is made in widths of 24-60 in. and thickness of $\frac{1}{8}$-$\frac{1}{2}$ in.

Stainless-clad material is likewise made from a "sandwich" composed of two plates of stainless steel between two plates of common steel. These "sandwiches" are also welded around the entire perimeter, the work being done in a special department at the plate mill. This department contains a grit blasting machine, a paint line for applying a separating compound between the inner faces of the stainless plates, and an automatic electric welding gantry. Clad material is rolled on the plate mill, with the lighter gages on the jobbing mills. This material is produced 6-48 in. wide, in thicknesses from $\frac{1}{4}$ in. down to No. 14 gage with 10 per cent cladding and down to No. 19 gage with 20 per cent cladding.

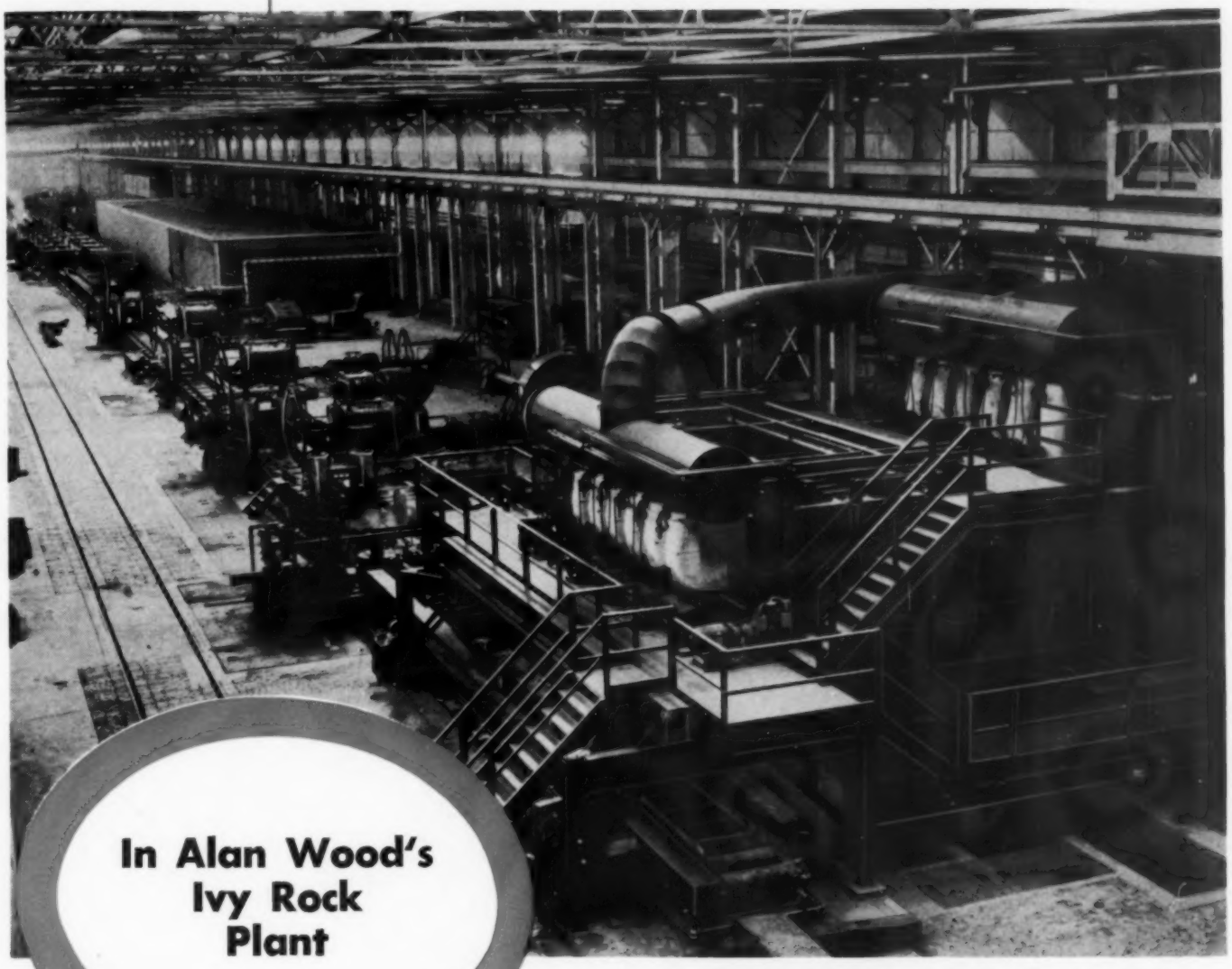
Another unusual product is sheet rolled for fabrication into well casing. This material is handled so as to finish with a hard red oxide which acts as a protective coating.

The cut nail department, which produces black, quenched and tempered or galvanized nails in sizes from 2-penny to 100-penny, is one of three plants in the United States turning out these items.

Another specialty are concentrates containing as much as 71 per cent iron, for use in the manufacture of iron powder. The company is now considering the complete manufacture of the powder, the demand for which is growing as powder metallurgy develops.

The central maintenance shop, containing complete machine, forge, blacksmith and welding shops, handles some construction work as well as the usual maintenance work.

UNITED
Mills and Equipment



In Alan Wood's Ivy Rock Plant

Alan Wood's new 30-in. Hot Strip Mill, the first in Eastern Pennsylvania

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

Making hay foot and straw foot march together was the purpose of the Alan Wood Steel Company in building its 30-inch continuous hot strip mill. Primary production far outran the capacity of finishing mills in the past. Now the two keep pace and total operation goes on to better advantage. UNITED designed and furnished the new parts.

GOLDEN ANNIVERSARY — U.E.&F.D. — 1901—1951

UNITED ENGINEERING AND FOUNDRY COMPANY
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Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
LOBDELL UNITED COMPANY, WILMINGTON, DELAWARE
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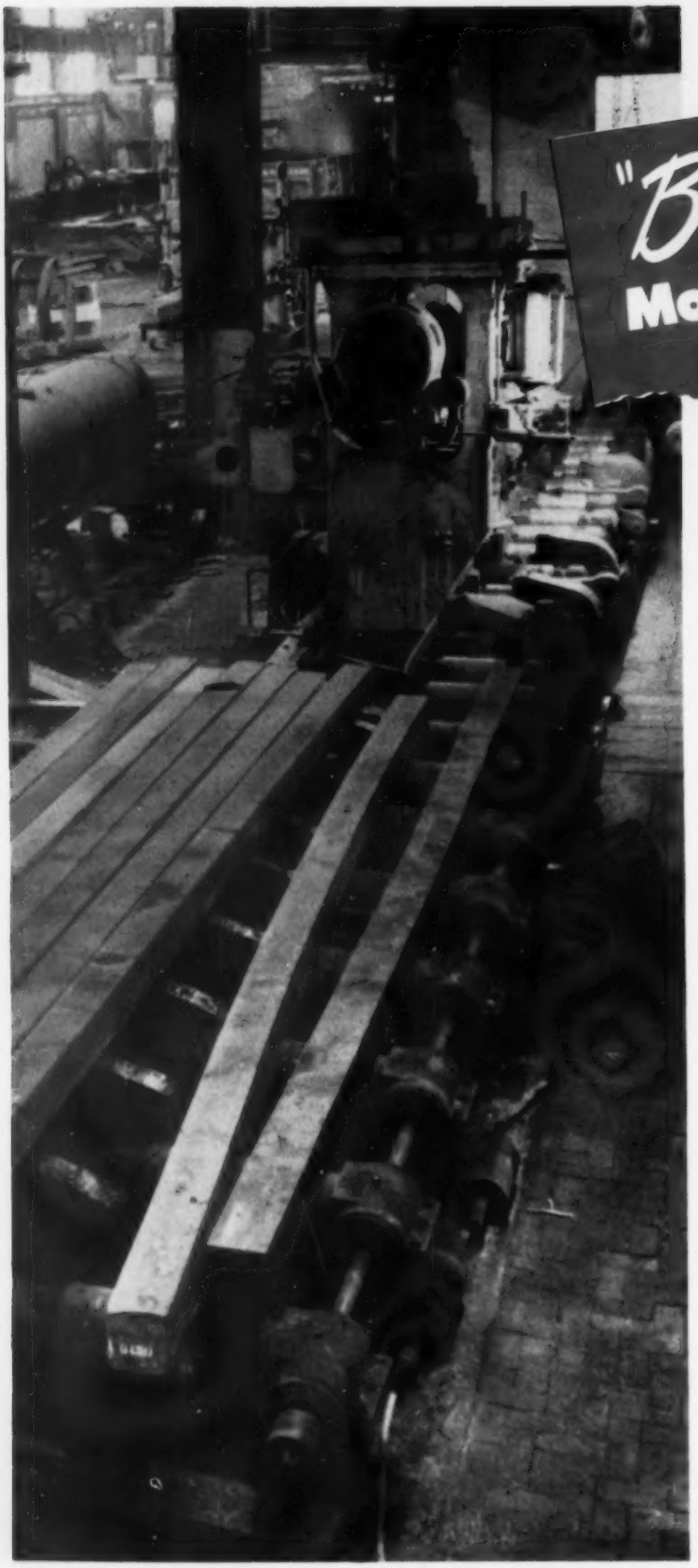


"Billeteering" Modernization...

at ALAN WOOD STEEL COMPANY

Alan Wood Steel Company modernized billet cleaning 10 years ago when *a Bonnot Billeteer was installed.*

A revelation in accurate billet conditioning—with its almost completely automatic operation, finger touch control, speed and safety—the Billeteer has increased output, improved quality and reduced manpower turnover—eliminated the drudgery, dangers and delays of billet-cleaning by hand.

Modernization with "Billeteering" reflects the foresightedness—in keeping abreast of the times at all times—with which Alan Wood Steel Company enters the *second quarter of its second century in business.*

Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

7 YEARS' SERVICE

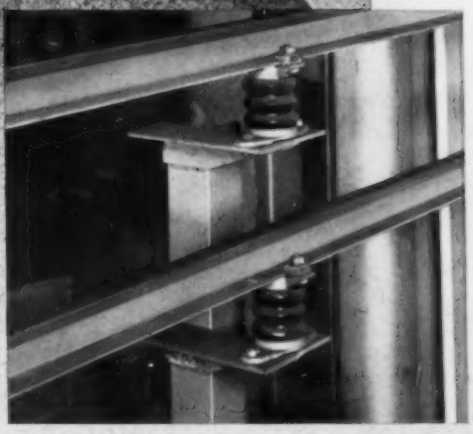
...STILL GOING STRONG AT ALAN WOOD STEEL

Keystone Collectors

Proof of the rugged, reliable service of Keystone equipment is found in the Alan Wood Steel plant at Conshohocken. Keystone Universal Collectors have been on the job for over seven years supplying positive contacts with an inverted "V" rail. Weather, dirt, grease did not impair their efficiency.

Positive contact, despite misalignment as great as 5″ vertical and 8″ horizontal, is assured with patented swivel base and head on Keystone Universal Collector. It is adaptable for all classes of industrial crane, conveyor and other work requiring a moving contact of medium power capacity.

Throughout Alan Wood Steel—as in other industrial plants—Keystone Collector and insulation equipment is in constant use in strip mill, coke plant, blast furnaces . . . wherever positive insulation and contacts are required. To cut maintenance . . . install Keystone. Write for latest catalog.



Keystone Contact Rail Insulator Type BHB at Alan Wood Steel. Clamps permit free movement of rail for contraction and expansion.

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PHILADELPHIA 32, PENNA.

"Tool Steel" Process PARTS

contribute to ALAN WOOD STEEL Co's efficiency...

1 "Tool Steel" Process

Randupson Bevels on 84" plate mill-tilting table.

2 "Tool Steel" Process

leveller rolls on United Leveller in 30" hot strip mill.

3 "Tool Steel" Process

wheel, gear and pinion in open hearth #9 charging crane.

* "Tool Steel" Process

PARTS are guaranteed to outlast any other materials used in the same service! These installations are typical of many applications of "Tool Steel" Process parts throughout Alan Wood Company's entire mill.

* "Tool Steel" Process

heat treating "know-how" (since 1909) can increase efficiency and cut costs in your operations.

* "Tool Steel" Process

engineers and representatives will be pleased to give you the facts.

1

2

3

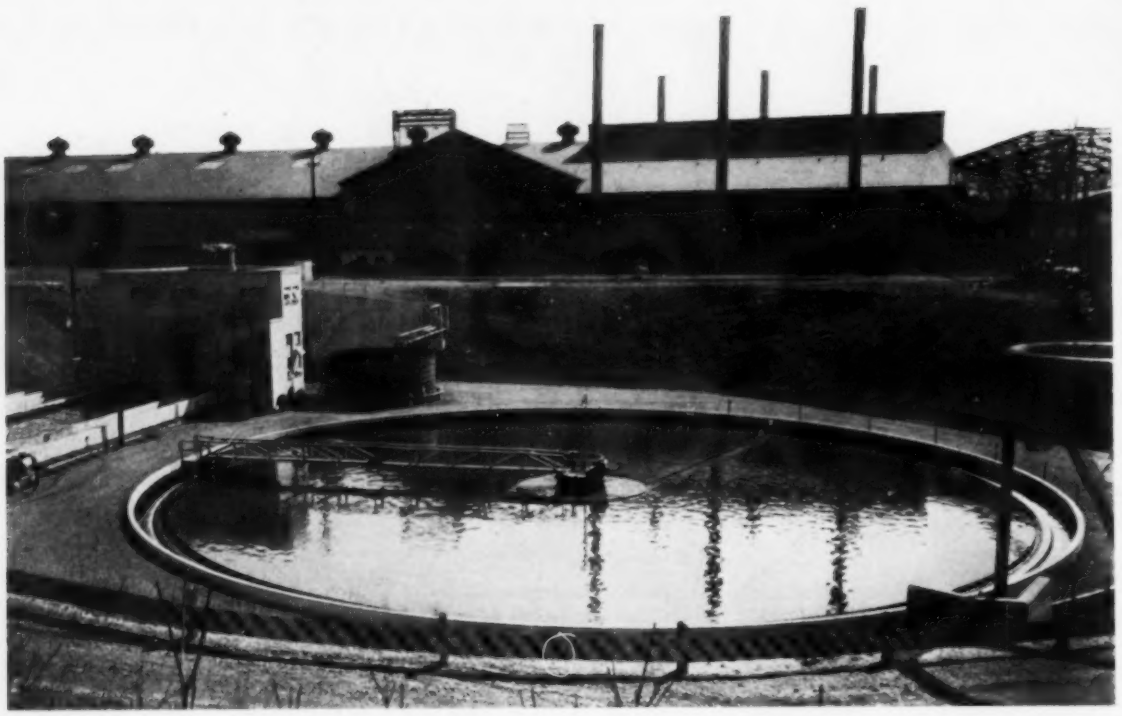
"Tool Steel" Process

The Standard of Quality

for GEARS • PINIONS • ROLLS • WHEELS *and other* HARDENED PRODUCTS

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO, U. S. A.



Mill Scale Water Clarification *made easy* at Alan Wood Steel Company

Shown in the photo above is a Dorr S-7 Clarifier treating mill scale waste water at the modern Alan Wood Steel Co. Mill at Conshohocken, Pa The rectangular tank at the left removes the heavy solids and most of the oil and grease. The overflow is introduced to the Clarifier by an inverted siphon arrangement which confines turbulence to the feedwell at the center.

The unit is 125 ft in diameter and is currently handling 7000 gpm of rolling mill waste water containing approximately 100 ppm of settleable solids. Also, about 5000 gpm of Schuylkill River water is pumped to the Clarifier for preliminary treatment prior to its use as makeup water. Clarifier overflow varies from 26 to 35 ppm of settleable solids depending on the characteristics of the incoming feed. An important feature of the mechanism is the skimming arm at water level which automatically removes any light oils that are not trapped out in the rectangular tank.

If you have a waste water problem, there's a good chance that one of the units in the Dorr line can do the job. For further information write The Dorr Co., Barry Place, Stamford, Conn. No obligation, of course.

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WORLD - WIDE RESEARCH · ENGINEERING · EQUIPMENT

THE DORR COMPANY · ENGINEERS · STAMFORD, CONN.

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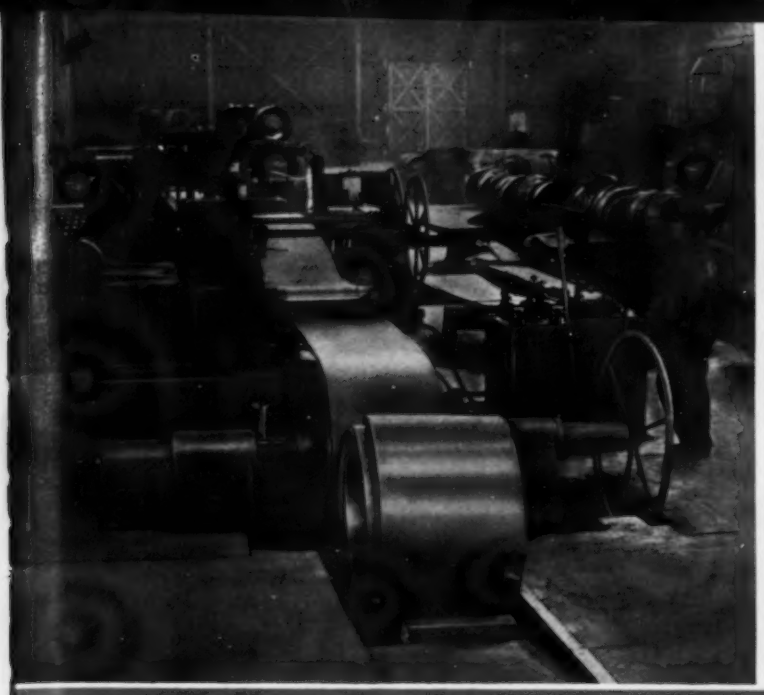


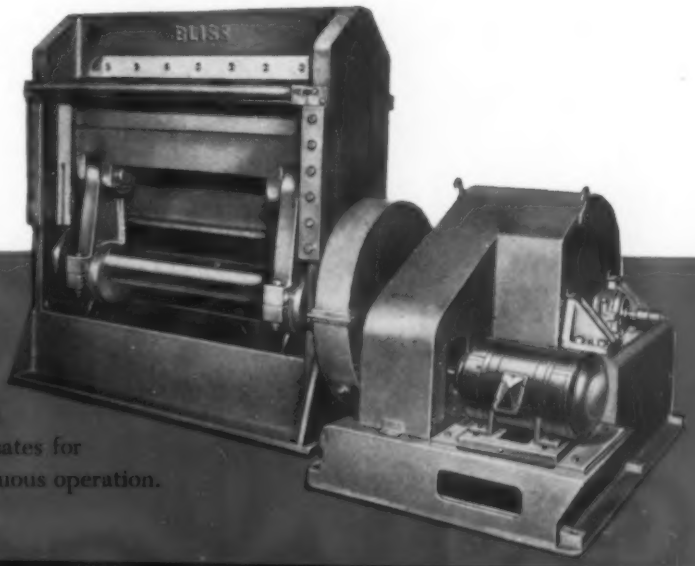
Transforms Coil to Sheet at Speeds up to 240 fpm

Bliss Shear Line at Alan Wood Steel Company Performs 9 Operations . . . from Feeding to Stacking

Converting coiled steel into uniformly flat sheet blanks—suitable for fabrication—is the job of this shear line, designed by Bliss for Alan Wood's 30-in. Hot Mill. Beginning at a coil stop, which delivers the coil to a cone pay-off, the coil is threaded to leveller, flattened, gauged to length, cut, oiled, fed and stacked. A transfer roller-table delivers piles of predetermined size ready for binding or banding to permit transfer to subsequent work station or shipment.

The Bliss shear line can be used in steel, brass or copper mills, warehouses or fabrication plants. Whether it's a jobbing shear line or an integrated steel plant, Bliss rolling mill engineers have the experience and facilities to take over the complete job. That's why Bliss rolling mill machinery is seen in almost every major metal-producing plant. You, too, will find it profitable to call on Bliss for mill equipment.

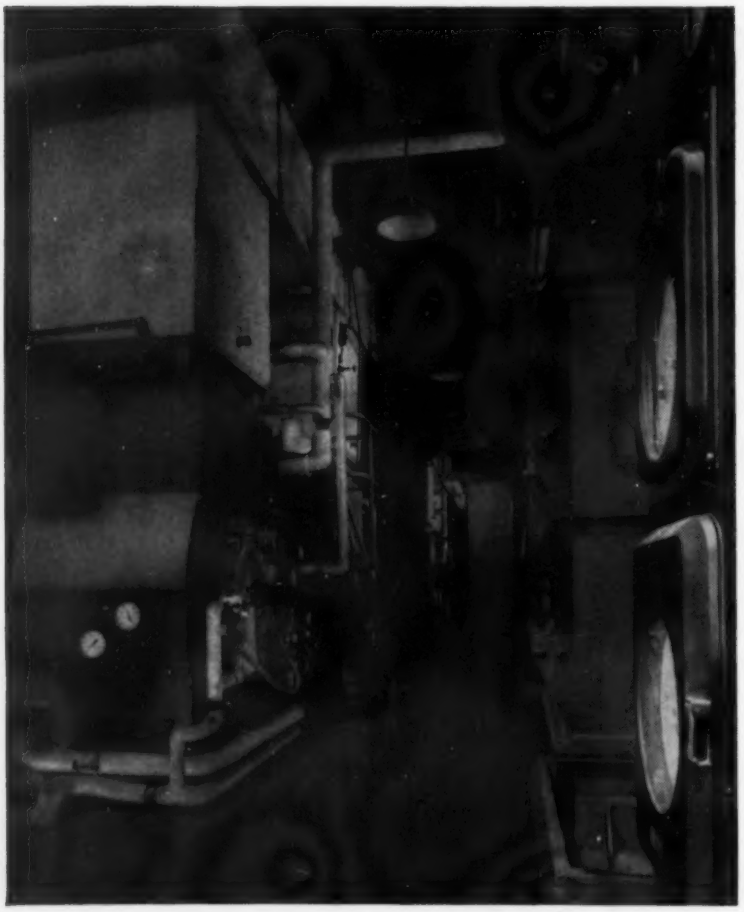
E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO



UPCUT SHEAR has solid-slab, one-piece frame for maximum rigidity. Single adjustment of knife-head compensates for wear. "Turnover" speed: 60 spm. in continuous operation.

Three-fuel boilers, with HAGAN at ALAN WOOD STEEL COMPANY

The two boilers in the Blast Furnace division of the Alan Wood Steel Company, Conshohocken, Pa., use blast furnace gas when it is available, coke oven gas when there is an unsold surplus, and Bunker C fuel oil when necessary.



General view of boilers. H. M. Wilson Co., Philadelphia engineering and construction firm were consulting engineers on this installation.

Each boiler has a capacity of 150,000 pounds of steam per hour. They are presently operating at 165 psig, but are designed for operation at 700 psig to meet future requirements.

Blast furnace gas has a heat value of approximately 90 BTU per cubic foot, and pressure varies from 5″ to 25″ water column. The heat value of coke oven gas is 540 BTU per cubic foot and fuel oil is 150,000 BTU per gallon.

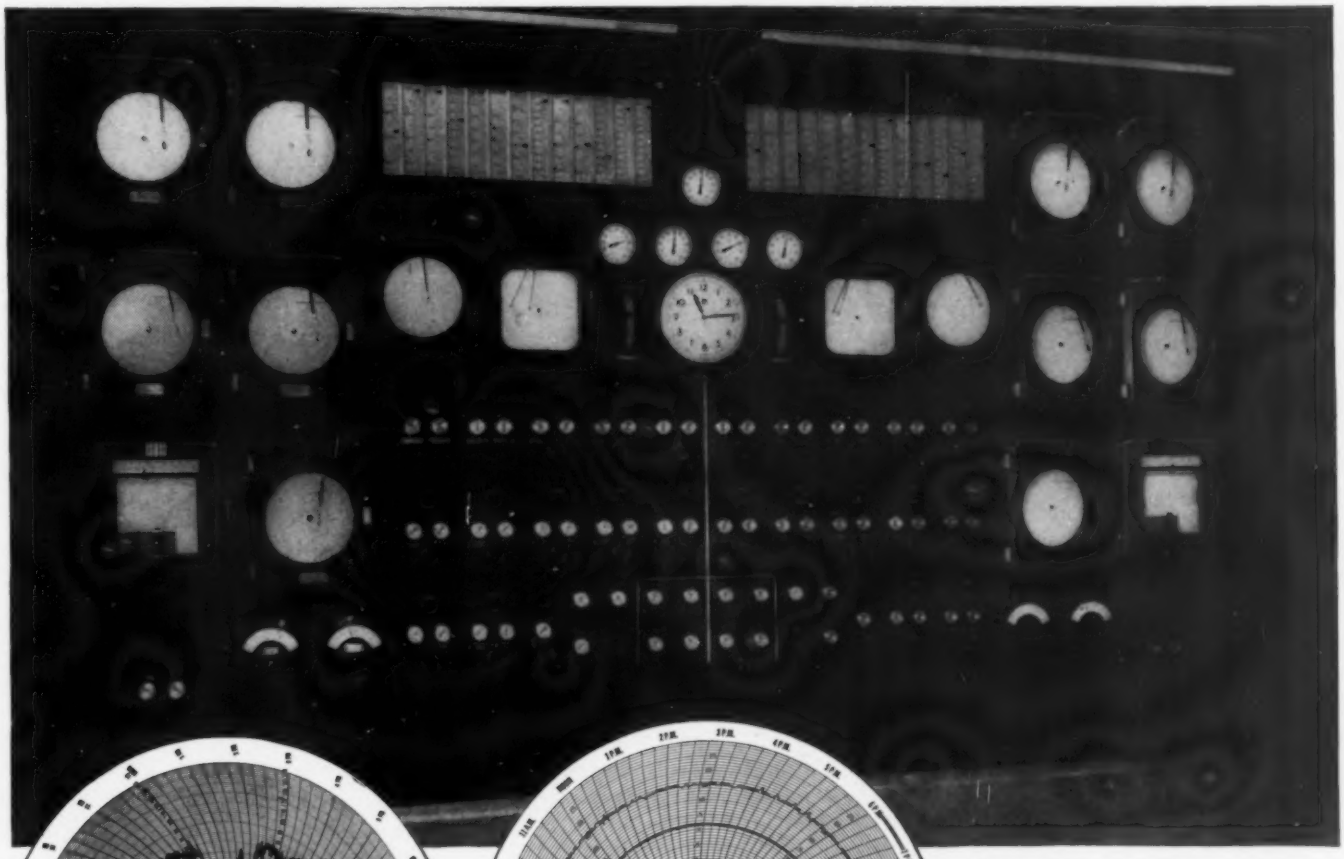
Fuels are burned in combination of either blast furnace gas and oil or coke oven gas and oil. Manual selection is used for type of gas, but the firing of the supplementary oil is fully automatic. The charts reproduced at the right show the compensating action of the oil firing control during a deficiency in the gas supply.

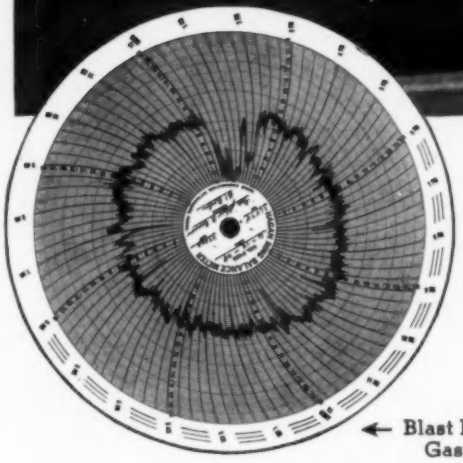
Despite the variables in the fuel supply, and the wide changes in steam load, the Hagan Automatic Combustion Control System has continuously maintained steam header pressure and fuel-air ratio ever since the boilers went in service in 1949.

Hagan Ring Balance Meters shown on the panel are used to measure and record gas flow, steam flow, and boiler water level. Two others, mounted on separate panels, measure flow of coke oven gas to the pilot burners.

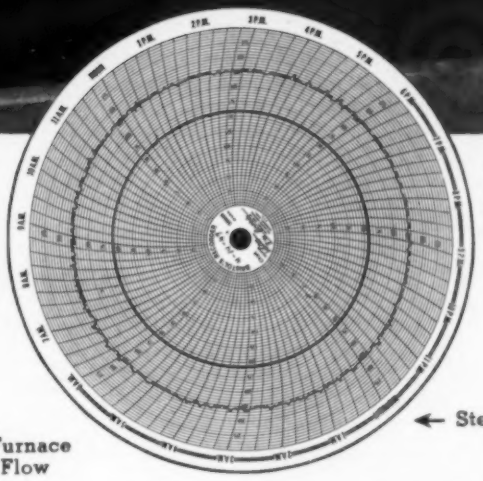
For full information on Hagan Control and Hagan Ring Balance Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

Controls and Meters





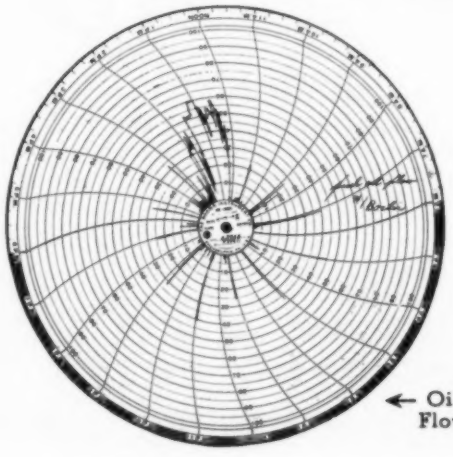
← Blast Furnace Gas Flow



← Steam Header Pressure (inner record)

Control Panel of Hagan Differential Master installation at Alan Wood Steel Company. Ten Hagan Ring Balance Meters are mounted on the panel, two more are mounted on separate panels.

The inner circle of this chart at the right shows how the Hagan Control maintained steam pressure under these conditions. Upper chart at left shows gas flow in one burner. "Valleys" in this chart are matched by peaks in the lower chart (oil flow). For the most part, it will be noticed, these "oil on" periods are of brief duration, but the charts show one period of several hours during which gas was off.



← Oil Flow

HAGAN CORPORATION

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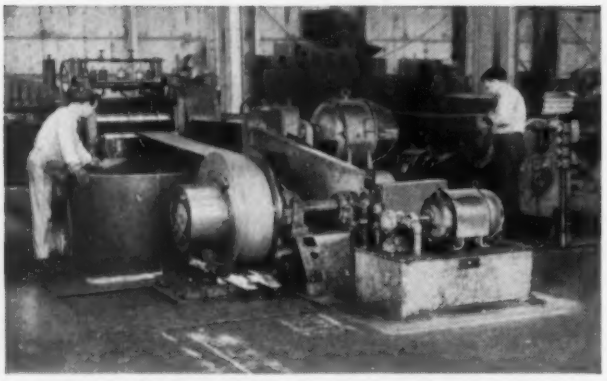
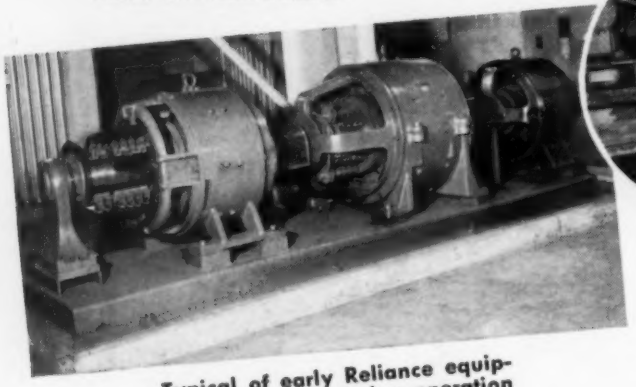
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

Thousands of RELIANCE MOTORS *help keep production up* IN THE STEEL INDUSTRY!

Roughing table installation of Reliance Type 'T' D-c. Motors



Reliance Motors power modern slitter and side trimmer

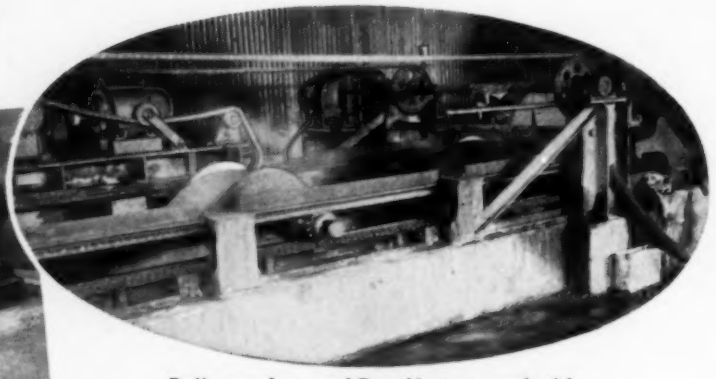


Typical of early Reliance equipment still in everyday operation

At Alan Wood Steel Company, for example...

since the first Reliance Motor went to work, more and more have been introduced in a constantly increasing variety of applications. As in mills everywhere, from the largest to the smallest, Reliance A-c. and D-c. Motors are providing dependable power to help this 125-year-old company keep production up and costs down. In the new Alan Wood 30-inch Hot Strip Mill, too, you will see the Reliance nameplate on rugged motors capably handling a wide range of heavy duty assignments.

Throughout the steel industry, Reliance Type 'T' Heavy Duty D-c. Motors are demonstrating by their performance under the most rugged service conditions their right to the title *"The Toughest Motors Ever Built"*. And Reliance Precision-Built A-c. Motors are proving that "made better to deliver dependable power *longer* means what it says.



Reliance A-c. and D-c. Motors work side by side on this continuous pickling line

Sales Representatives in Principal Cities

RELIANCE ELECTRIC AND ENGINEERING CO.

"All Motors are NOT Alike" • 1084 Ivanhoe Road, Cleveland 10, Ohio

Specify:

"MARTINDALE" for MAINTENANCE

COMMUTATOR MAINTENANCE **ELECTRICAL MAINTENANCE**

MOTOR MAINTENANCE **MECHANICAL MAINTENANCE**

The Steel Industry, as well as many other industries, has made "MARTINDALE" virtually synonymous with "maintenance."

For over 35 years, MARTINDALE equipment has played a part in the important job of keeping production equipment operating at peak efficiency.

PICTURES BELOW WERE MADE AT ALAN WOOD STEEL CO.

AT LEFT:
Undercutting commutator mica with a Martindale "Mica-Miller" Undercutter and Martindale High Speed Steel V-Cutters.

BELOW:
Resurfacing commutator with a Martindale "Commstone" in Alan Wood's Blooming Mill motor room.

MARTINDALE MAINTENANCE EQUIPMENT INCLUDES:

- Mica Undercutters (9 types)
- Mica Saws and "V"-Cutters
- Martindale "Commstones"
- Martindale Commutator Grinders
- Martindale Commstone Holders
- Martindale Slot Cleaning Outfits
- Martindale Hand Tools for Motor Repair
- Martindale Growlers
- Martindale "Tong-Test" Ammeters
- Martindale Megohm Tester & Voltmeter
- Martindale Spiral Expansion Reamers
- Martindale Wire Strippers
- Martindale Wheel and Gear Pullers
- Martindale Electric Etchers
- Martindale Portable Electric Blowers
- Martindale Protective Dust Masks and other time-saving tools

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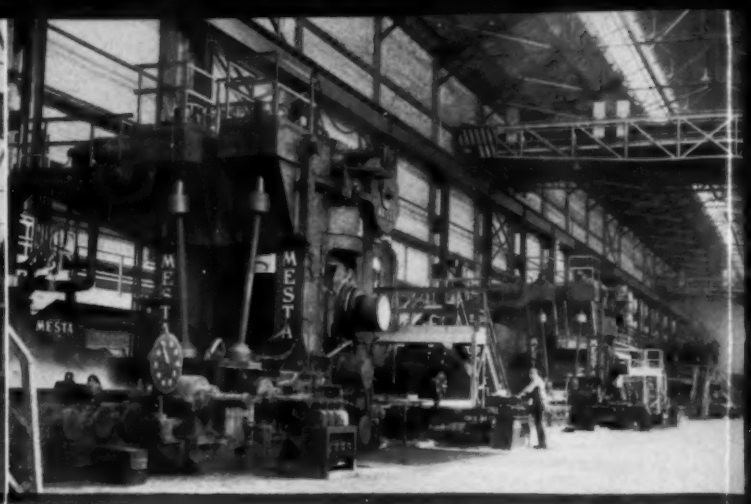
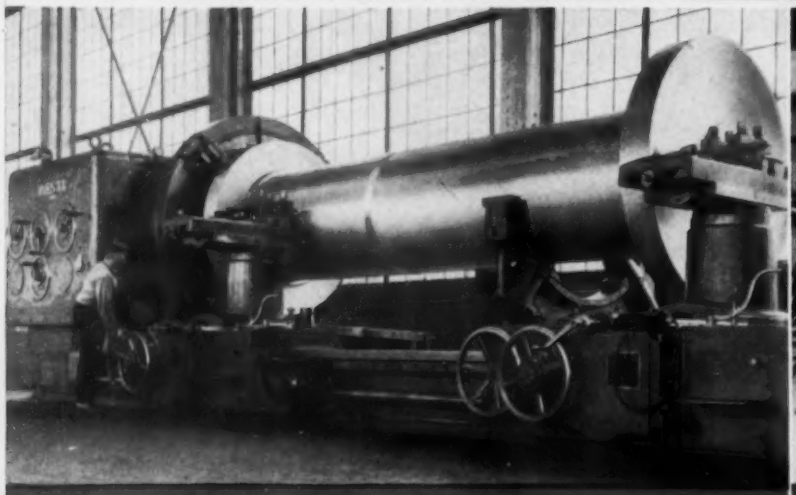
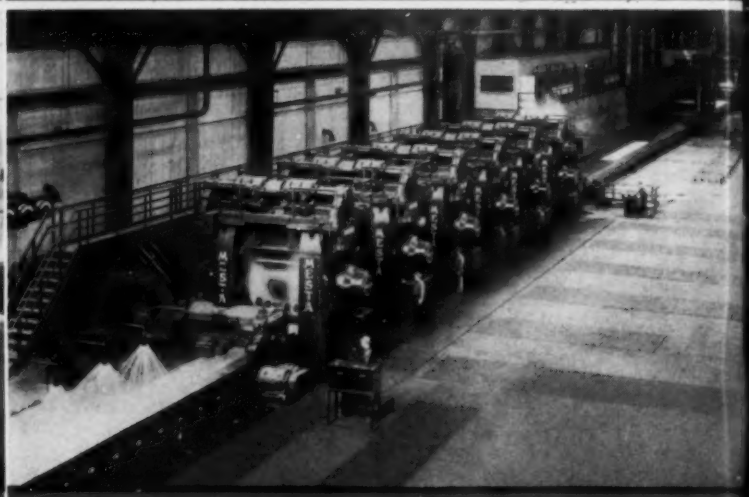
MESTA HEAVY DUTY TRAVELING WHEEL TYPE ROLL GRINDER



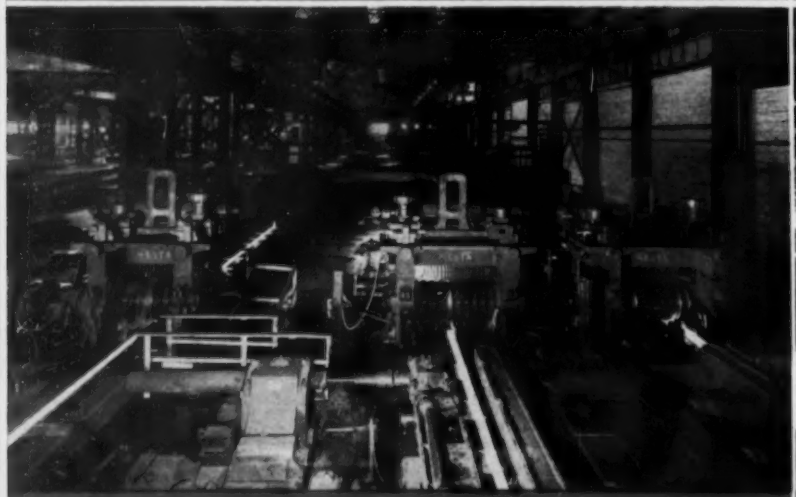
MESTA 44" FOUR-HIGH CONTINUOUS HOT STRIP MILL



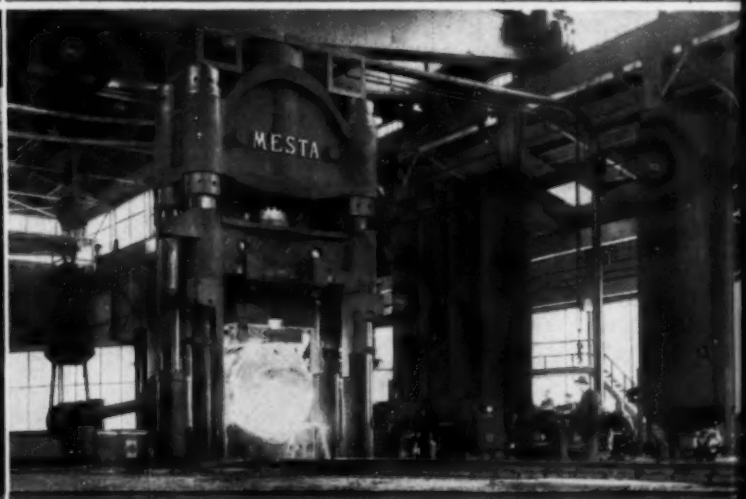
MACHINING A FORGED STEEL ROTOR SHAFT FOR A TURBINE DRIVEN GENERATOR



MESTA 80" FOUR-HIGH CONTINUOUS HOT STRIP MILL

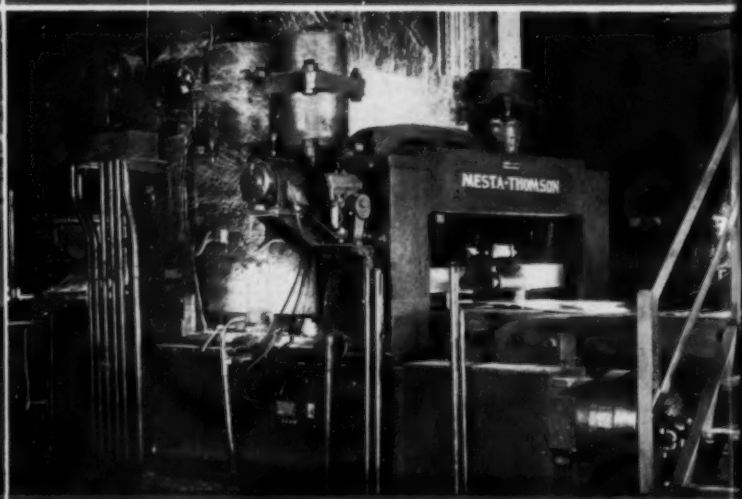


MESTA 32" BAR MILL SHOWING INTERMEDIATE, LEADER, AND FINISHING STANDS

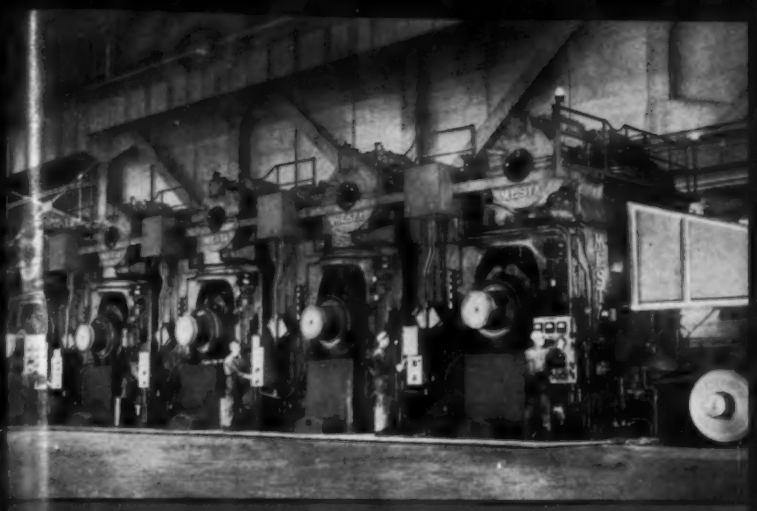


FORGING A LARGE INGOT ON A MESTA 4,000 TON HYDRAULIC PRESS

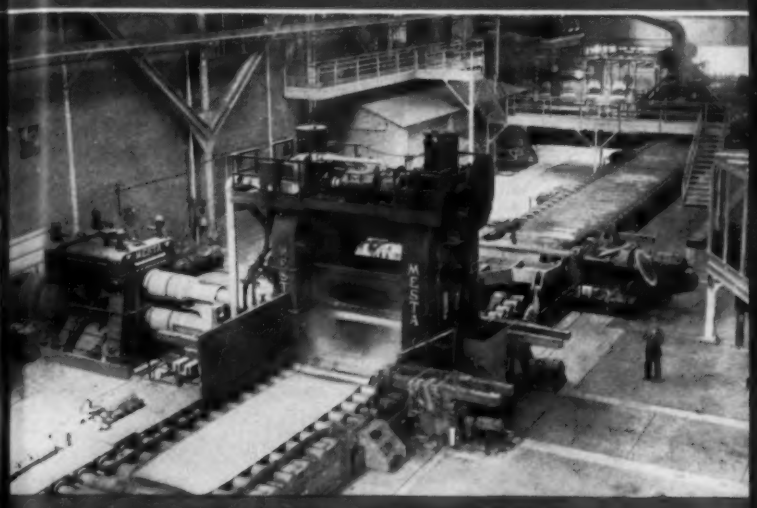
GROUP OF THREE 32" MESTA PATENTED



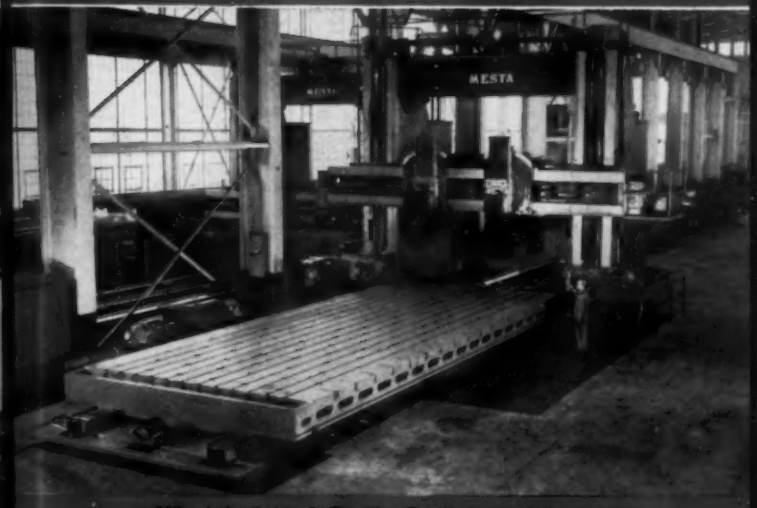
MESTA-THOMSON FLASH WELDER INSTALLED IN A



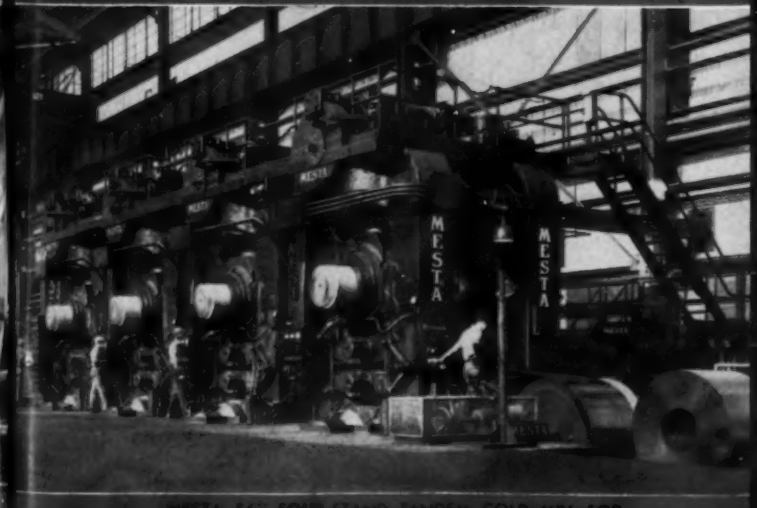
MESTA 42" FOUR-HIGH, FIVE-STAND TANDEM HIGH SPEED COLD MILL



MESTA 110" FOUR-HIGH REVERSING PLATE MILL



MESTA 14' HEAVY DUTY TRAVELING TABLE TYPE PLANER



MESTA 56" FOUR-STAND TANDEM COLD MILL FOR

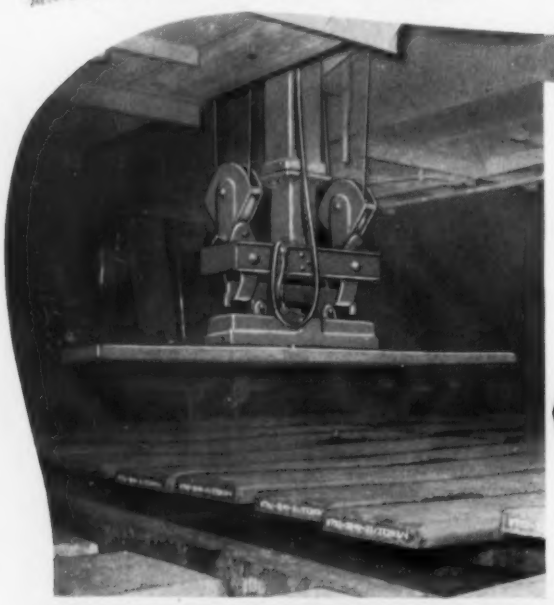
Designed and Built By

MESTA

MACHINE COMPANY

PITTSBURGH, PENNA.

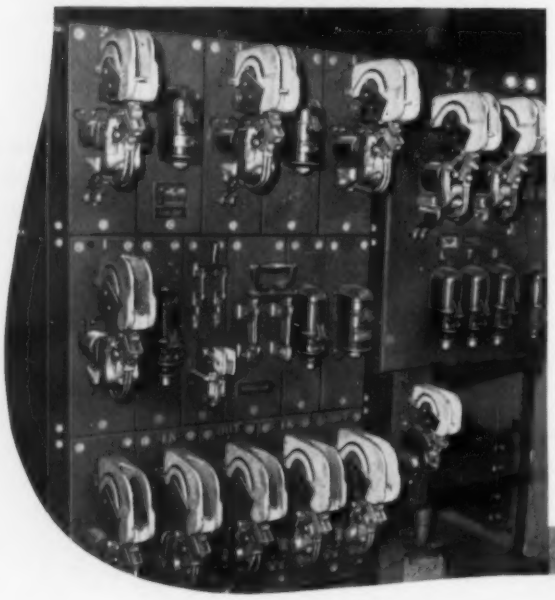
In many ways EC&M PRODUCTS *serve* ALAN WOOD STEEL COMPANY *on its 125th anniversary*



MAGNETS

The *All-Welded* EC&M Type SW Lifting Magnet speeds handling in ingot yard.

EC&M Type P Magnets of Bi-polar design turn over slabs for scarfing operation. Note stirrup-hanger for magnet.



CONTROL

Time-Current Magnetic Controller for Coke Oven Pusher Ram.

RESISTORS

TAB-WELD Resistors are now used on ladle and other mill cranes.

also YOUNGSTOWN SAFETY LIMIT STOPS ON CRANE-HOISTS

EC&M Magnets and Motor Control have a reputation for long life with low upkeep in steel mill service. The fundamental features built into all EC&M apparatus contribute to efficient operation with minimum inspection and maintenance.

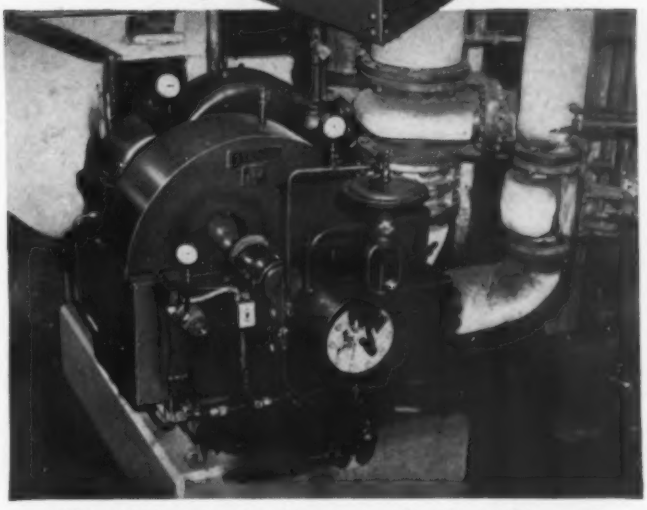
Specify EC&M when buying magnets and motor control.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

Alan Wood Steel Company likes them—

ELLIOTT *Mechanical Drive* TURBINES

■ For the past ten years the Alan Wood Steel Company has been steadily increasing the number of Elliott turbines in their Conshohocken plant. These units are used to drive boiler and condenser auxiliaries, as well as service pumps. Repeat orders over the years prove the reliability of these husky turbines. They make good in a big way. This, plus their extreme adaptability, through their many permissible modifications, strongly influences their selection whenever expanded facilities require more turbine drives. They are as easy on maintenance costs as they are on the tempers of plant executives. Bulletin H-16 gives a number of good reasons. Write for a copy.



Elliott 600-hp geared turbine equipped with variable speed orifice governor driving an induced-draft fan in the Alan Wood Steel Company plant.

Other ELLIOTT equipment for steel plants...

"FABRI-STEEL" MOTORS—Welded steel ruggedness and pronounced reliability have gained them a top reputation.

ELLIOTT CROCKER-WHEELER MOTORS in a range of types and enclosures, 1 to 200 hp, including the 600 Series DC Mill Motor.

Centrifugal blowers for blast furnaces, Bessemer converters, coke ovens • Strainers—twin, self-cleaning • Turbine-Generator Units • Deaerating feedwater heaters • Condensers • Tube cleaners

1901 1951

H-735

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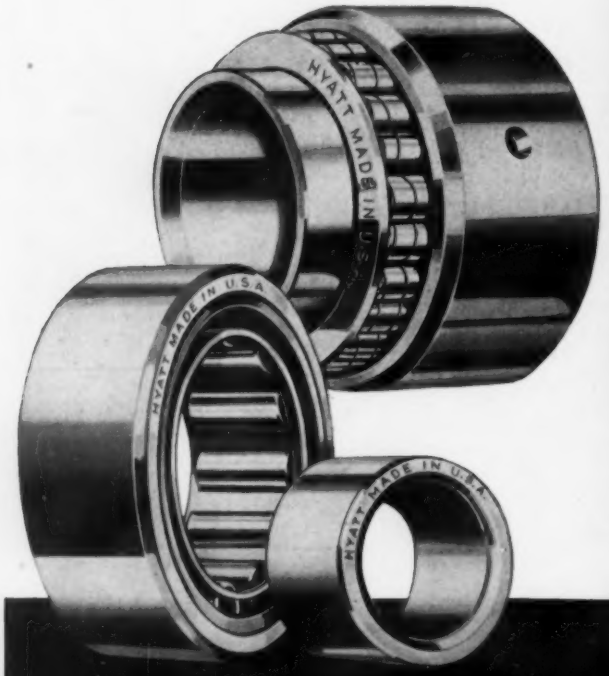
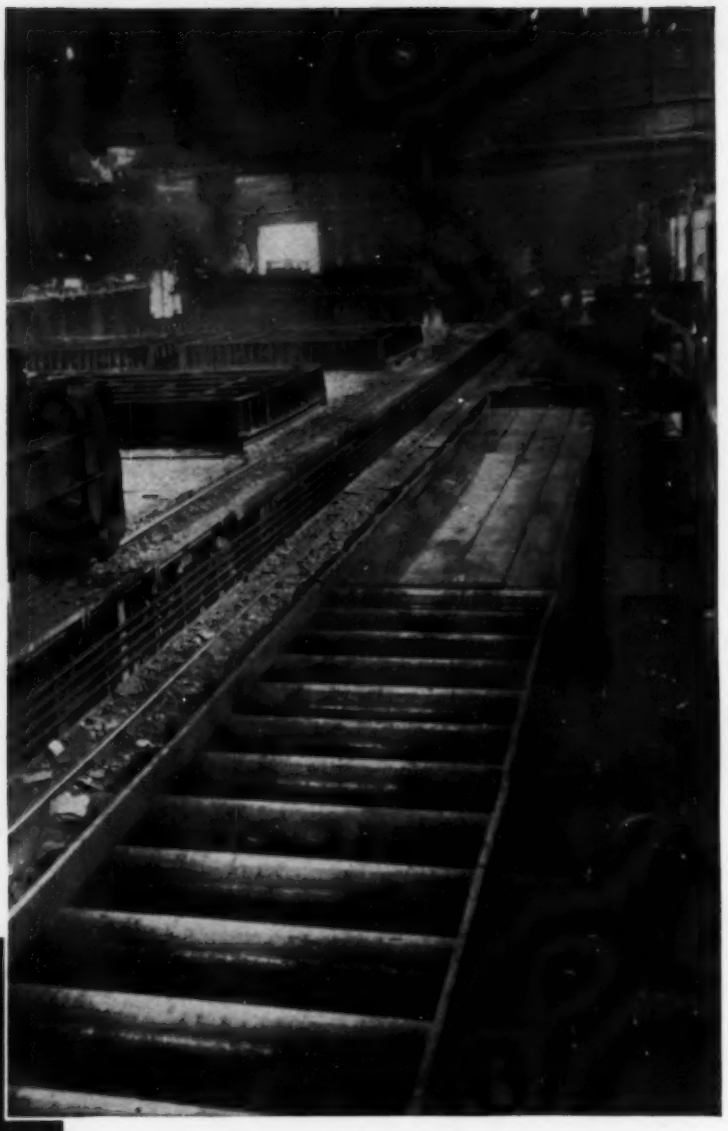
Congratulating—

ALAN WOOD STEEL COMPANY





HYATT salutes the Alan Wood Steel Company on their 125th Anniversary, and we are proud of our long association with them as a supplier.

Daily justifying our pride, are the many Hyatt Roller Bearings operating so successfully in their cars, plate mill tables, and strip mill applications.

Long associations are the rule, rather than the exception, with Hyatt Roller Bearings. Designed for rugged steel mill service and backed by performance records and application engineering experience second to none, Hyatts have established themselves as the preferred steel mill bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Chicago; Pittsburgh; and Oakland, Calif.

HYATT ROLLER BEARINGS

BROWN INSTRUMENTATION IS THE *Plus-Factor*

Critical annealing job
ACCURATELY CONTROLLED

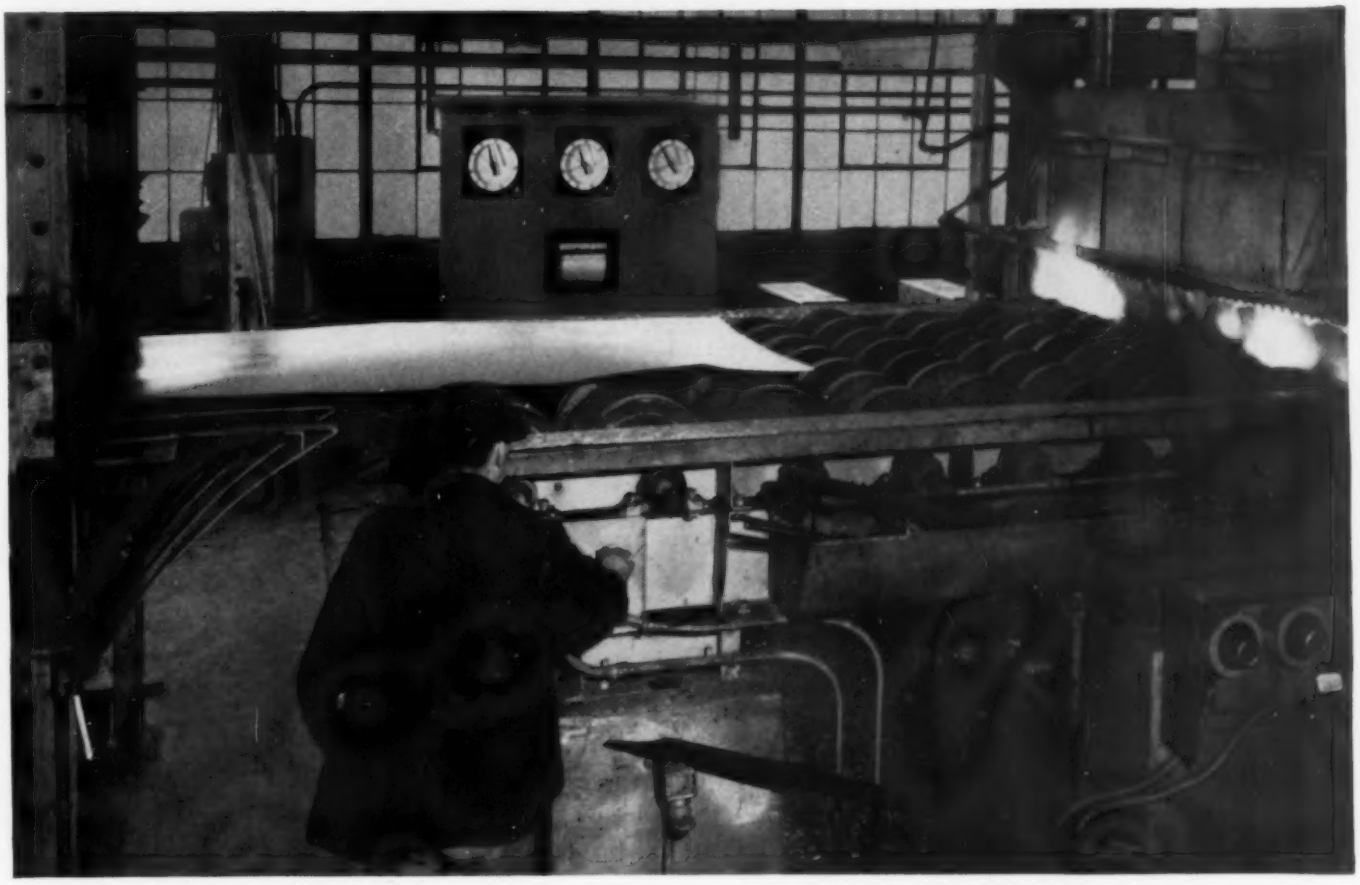


Photo Courtesy of Alan Wood Steel Company

Permaclad, Alan Wood's stainless clad steel, combines the surface characteristics of solid stainless with the easy forming qualities of mild carbon steel.

Accurate temperature control of continuous annealing furnaces is important in producing this quality steel. The stainless layer is diffusion welded to the mild steel backing in a layer of 10% of total thickness for sheets #13 gauge and heavier, and 20% for lighter sheets. The stainless clad carbon sheets are annealed in pairs, stainless sides together, and run through the furnace at a speed determined by the sheet gauge.

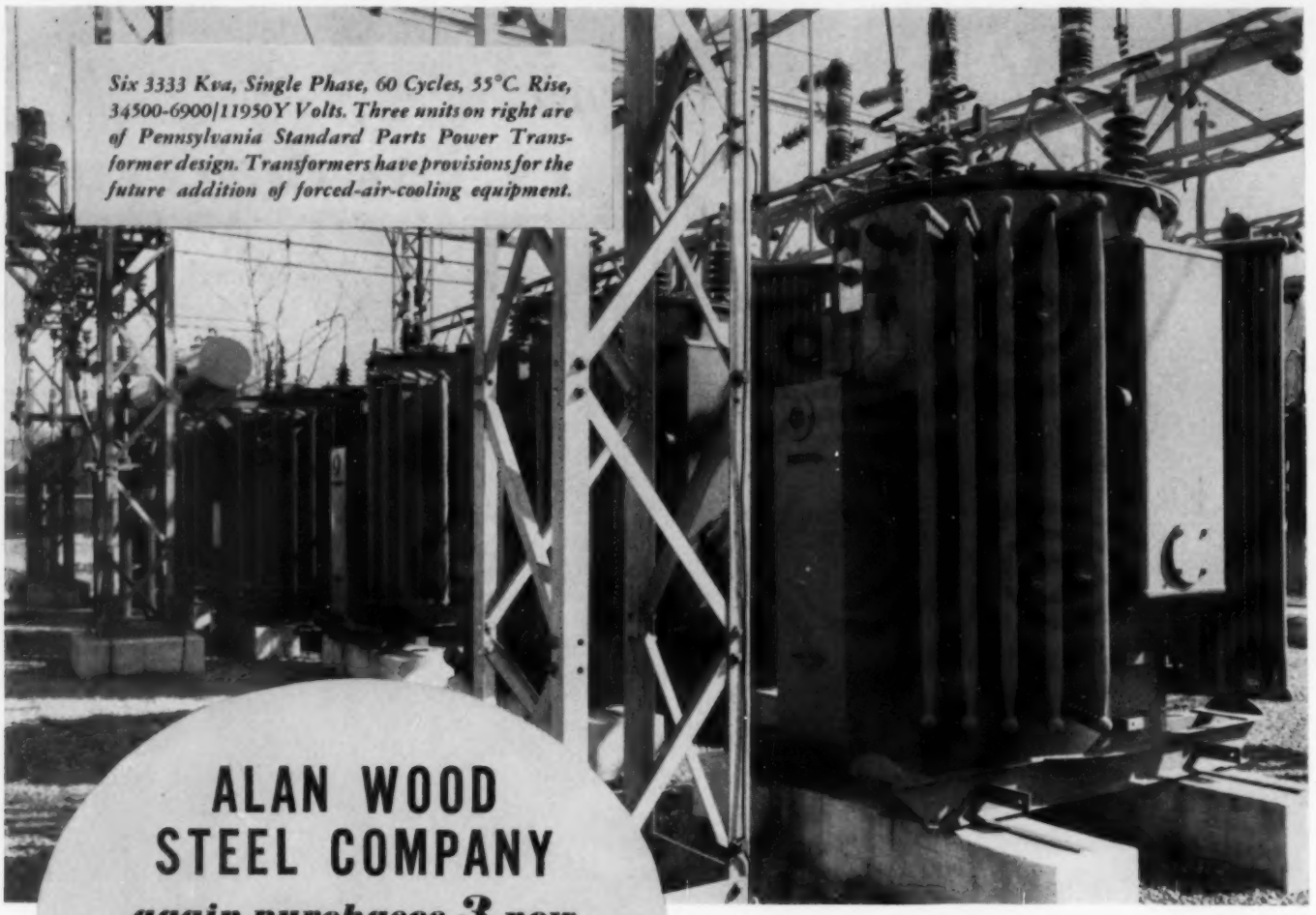
Furnace temperatures from 1950 to 2000°F. are measured by the *Radiamatic* sensing elements and controlled by *ElectroniK* Pneumatic Controllers. The sensitive measurements, and the precise control of heat by these instruments, afford a highly efficient zone control system that maintains correct firing rates for varying furnace loads. Such dependable performance is being repeated by *ElectroniK* indicating and recording controllers throughout the metals industry . . . delivering top-quality products at lowest cost.

Call in your local Honeywell engineer for a discussion of your utilization of *ElectroniK* control . . . he is as near as your phone!

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Avenue, Philadelphia 44, Penna. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS



Six 3333 Kva, Single Phase, 60 Cycles, 55°C. Rise, 34500-6900/11950Y Volts. Three units on right are of Pennsylvania Standard Parts Power Transformer design. Transformers have provisions for the future addition of forced-air-cooling equipment.

ALAN WOOD STEEL COMPANY

again purchases 3 new PENNSYLVANIA STANDARD PARTS POWER TRANSFORMERS

Pennsylvania TRANSFORMERS

RECENTLY, three new Pennsylvania Power Transformers, with a total rating of 10,000 Kva, were put into service alongside three older Pennsylvania Transformers with a similar rating. Though both banks of transformers have the same electrical characteristics, there is a decided difference between the old and the new group of transformers. The new units are Pennsylvania Standard Parts Power Transformers, which have certain distinct advantages for the user:

1. Definite savings are effected by the purchase of Pennsylvania Standard Parts Power Transformers. These savings are made possible by the use of standard designs, standard parts, and standard methods of manufacturing, which shorten engineering and production time.

2. The purchaser is able to select the method of oil preservation that he prefers without any price penalty. The transformers illustrated above are equipped with an inert gas, oil pressure system.

3. The transformers feature the many new design improvements built into Pennsylvania Standard Parts Power Transformers. Included are:

   A. a new improved structural steel base which simplifies the important problems of jacking, pulling, rolling and painting;

   B. a new streamlined radiator designed to facilitate cleaning and painting in the field.

For more complete information on Pennsylvania Standard Parts Power Transformers, write to Pennsylvania Transformer Co., Box 330, Canonsburg, Pa.

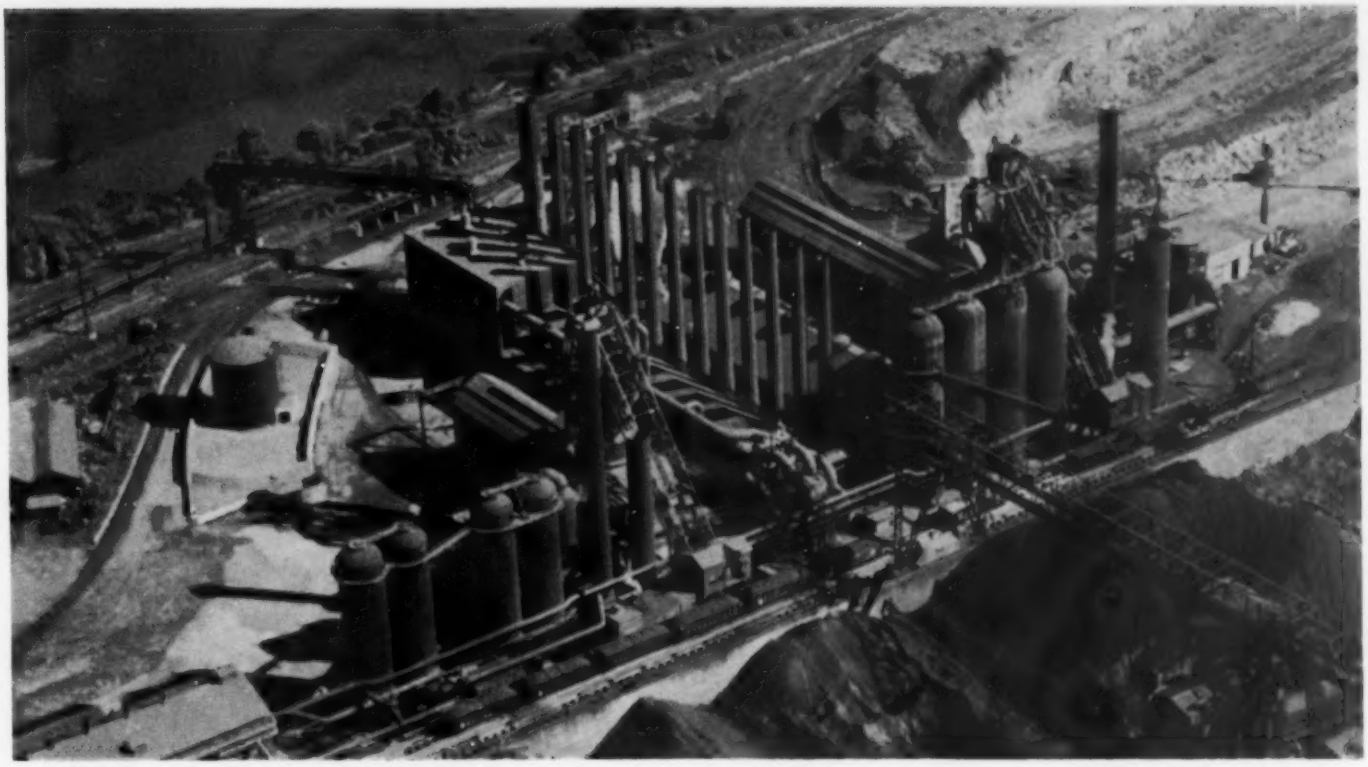
What are Pennsylvania Standard Parts Power Transformers?

They are single phase transformers in sizes up to 5000 Kva, 69 Kv, and three phase transformers in sizes up to 10,000 Kva, 69 Kv. Transformers are "Standard" when they conform to standard voltage ratings, have standard taps and standard impedances, and are equipped with standard accessories in standard locations. For such transformers a full discount is applied. When voltages are not standard, but within a certain voltage range, slightly lower discounts are applied.

Pennsylvania

TRANSFORMER COMPANY

CANONSBURG, PA. • *Greater Pittsburgh District*



Both ALAN WOOD BLAST FURNACES *are lined* THROUGHOUT *with* HARBISON-WALKER *blast furnace brick*

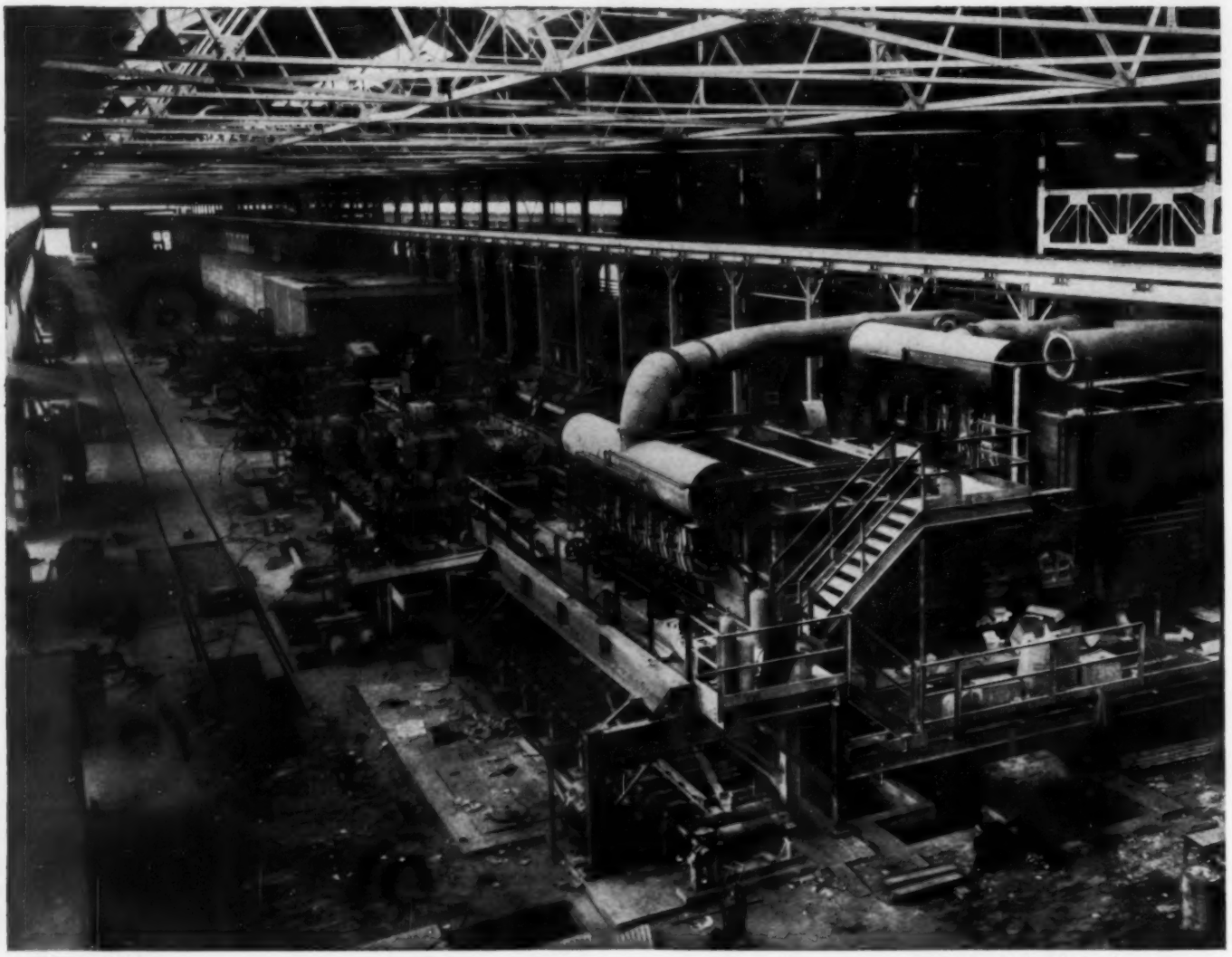
This 125-year old producer of iron and steel employs modern techniques and equipment in its operations. Harbison-Walker refractories are used in various furnaces—and their two blast furnaces are lined *throughout* with Harbison-Walker Blast Furnace Brick. The selection of Harbison-Walker refractories for the complete linings of their two blast furnaces is the logical development of long and satisfactory experience with these products.

Whether your blast furnace practice calls for the best standard conventional linings or for super-duty linings, Harbison-Walker produces the refractories best suited for your specific needs with the following leading brands:

BENEZET (Pa.)
and H-W (Ky.)—*High Duty*
H-W 18—*Special High Duty*
VARNON—*Super-Duty*

Harbison-Walker provides refractories especially suited for every furnace requirement of the iron and steel industry. Further expansion of manufacturing facilities are in progress to take care of the constantly increasing demand for Harbison-Walker products.

HARBISON-WALKER REFRACTORIES CO.
AND SUBSIDIARIES
World's Largest Producer of Refractories
General Offices: Pittsburgh 22, Penna.



Hot Strip Mill — Alan Wood Steel Company

ON SCHEDULE – WITHIN THE ESTIMATE

We offer complete service in steel mill engineering and construction—one contract with full responsibility for time and cost. From preparation of drawings to erection of equipment, we work under the direction—and in fact as a part—of the owner's organization.

No matter what your project—a steel mill; a power, industrial or process plant; railroad facilities; or an office building—we invite you to share our experience and facilities as designers, constructors and consulting engineers.

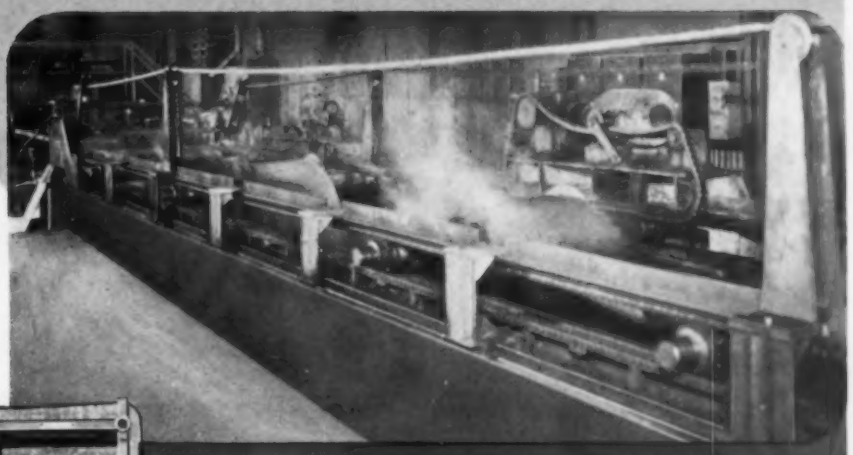
UNITED ENGINEERS & CONSTRUCTORS INC

NEW YORK 17 **PHILADELPHIA 5** **CHICAGO 2**

WITH A BACKGROUND OF OVER SIXTY YEARS' EXPERIENCE

IT'S CLARK CONTROL

FOR STEEL MILL PROCESSING LINES



L. W. NASH-GREER COIL PICKLING LINE

CLARK CONTROL PANELS

Shown is a section of the L. W. Nash-Greer Coil Pickling unit in The Alan Wood Steel Company, Conshohocken, Pennsylvania.

This is one of the many processing lines operating successfully in this plant with CLARK control, furnished in conjunction with The Reliance Electric and Engineering Company's heavy-duty AC and DC Motors.

The *left side* of the cabinet shows the AC control for the motors for Coils Reverse Rotation, Delivery Reel Feed, Delivery Up-Ender, and Mandrel Return Conveyor. The *right side* of the cabinet shows a CLARK Bulletin 9320 VARI-TIME Mill Control for use with the Delivery Reel Motor. *On top* of the cabinet are CLARK Bulletin 110 Edgewound Resistors. At the *extreme top left* of the cabinet is a ventilating duct which supplies pure air to prevent corrosion of electrical control equipment.

Other cabinets housing CLARK Control for the Entry Reel Motor, Chain Conveyor, Entry Up-Ender and other drives are shown in the background of the illustration above.

The heart of all CLARK DC Control is the VARI-TIME Contactor, which has the built-in principle of delaying — for an adjustable definite time — the closing of its main contacts after the coil is energized. Thus accelerating relays are eliminated, wiring is simplified, and maintenance is lowered.

There's a CLARK CONTROL for every Steel Mill Processing Line

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

2 MODERN 'SURFACE' INSTALLATIONS

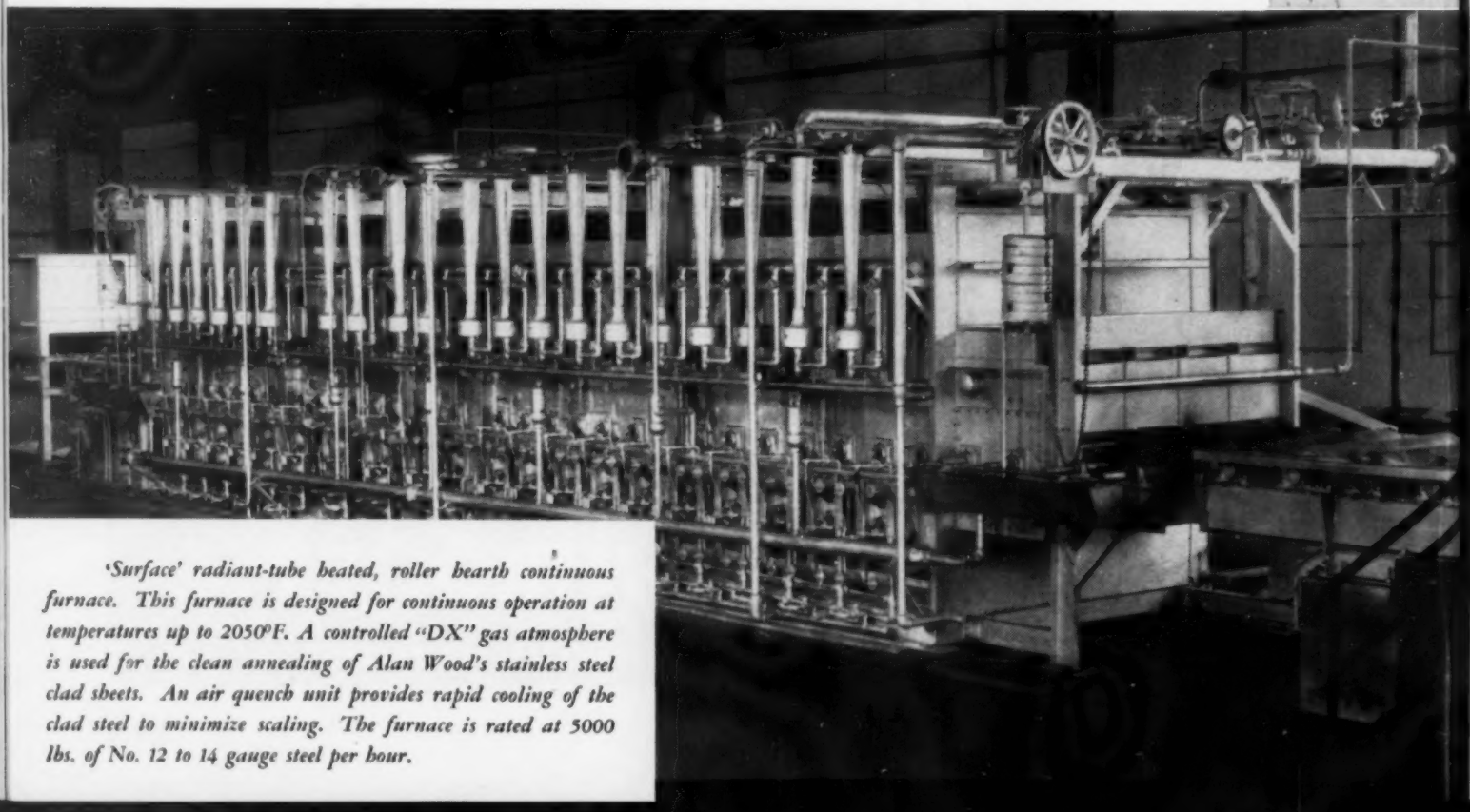
ROLLER-HEARTH ANNEALING AND NORMALIZING FURNACE

SLAB REHEATING FURNACE

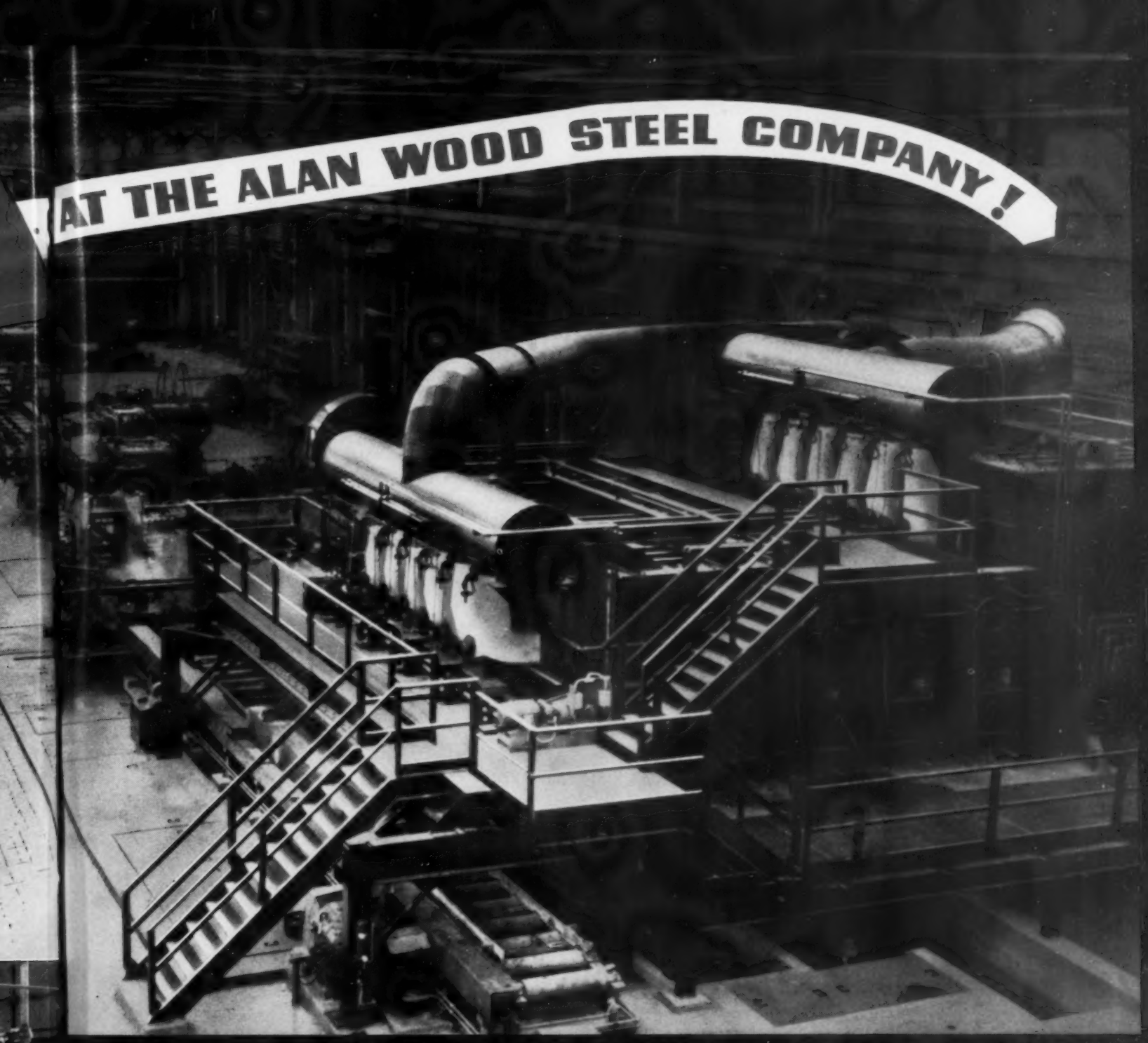
The Surface Combustion Slab Reheating Furnace and the Roller Hearth Annealer shown here are integral parts of the new Alan Wood Mill. Whatever the job—heating and heat treating of metals—'Surface' can furnish the knowledge, experience and equipment to meet the requirements. A 'Surface' engineer will be glad to call and discuss your heating and heat treating problems at your convenience.

Specially designed units for specific purposes are represented by the 'Surface' Roller Hearth Annealing and Normalizing Furnace used for heat treating stainless clad sheets. This radiant-tube fired furnace permits the annealing and normalizing of the clad steel sheets at temperatures to 2050°F., with minimum scaling of the carbon steel backing.

This 'Surface' Slab Reheating Furnace is one of many installations in the steel industry ranging up to the largest such furnace in the world. All common fuels are used in these furnaces. Recuperators and automatic temperature, combustion and draft controls are featured. →



'Surface' radiant-tube heated, roller hearth continuous furnace. This furnace is designed for continuous operation at temperatures up to 2050°F. A controlled "DX" gas atmosphere is used for the clean annealing of Alan Wood's stainless steel clad sheets. An air quench unit provides rapid cooling of the clad steel to minimize scaling. The furnace is rated at 5000 lbs. of No. 12 to 14 gauge steel per hour.



SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON

STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

'Surface' SERVES THE STEEL INDUSTRY

One-Way Fired Soaking Pits • Billet Reheating Furnaces • Slab Heating Furnaces • Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces • Controlled Atmosphere Annealing Covers for Wire and Rod • Controlled Atmosphere Annealing Covers for Coil and Sheets • Continuous Furnaces for Heat Treatment of Steel Plate • Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock • Continuous Type Bright Annealing and Normalizing Furnaces • Prepared Gas Atmosphere Generating Equipment • Pit Type Convection Furnaces for Rod Annealing • Stress Relief Furnaces • Wire Patenting Furnaces

THE *Shape* . . . CAN'T *be* COPIED!

Patented

The Nonbreakable Steel Grid Resistor

6th. Repeat Order

Amsler Morton Furnaces again chosen at the Alan Wood Steel Corp.

AMCO

***World's foremost builders of* INDUSTRIAL HEATING FURNACES**

The Patented AMCO Recuperators are used in all of the above furnaces.

Send for Recuperator Bulletin No. 292

Amsler Morton Corp.

CHAMBER OF COMMERCE BLDG., PITTSBURGH 19 PENNSYLVANIA

ON THE JOB FOR 32 YEARS

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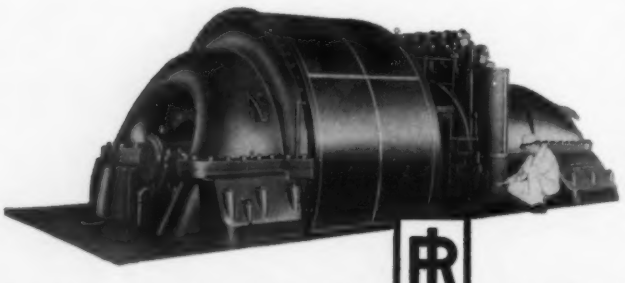

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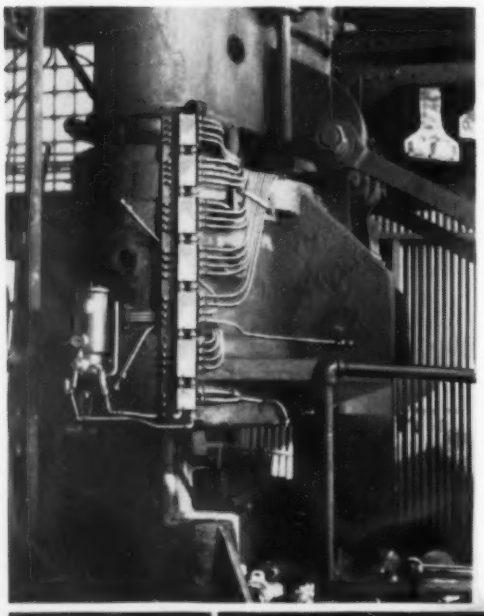
The Cleveland Worm & Gear Company, 3278 E. 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

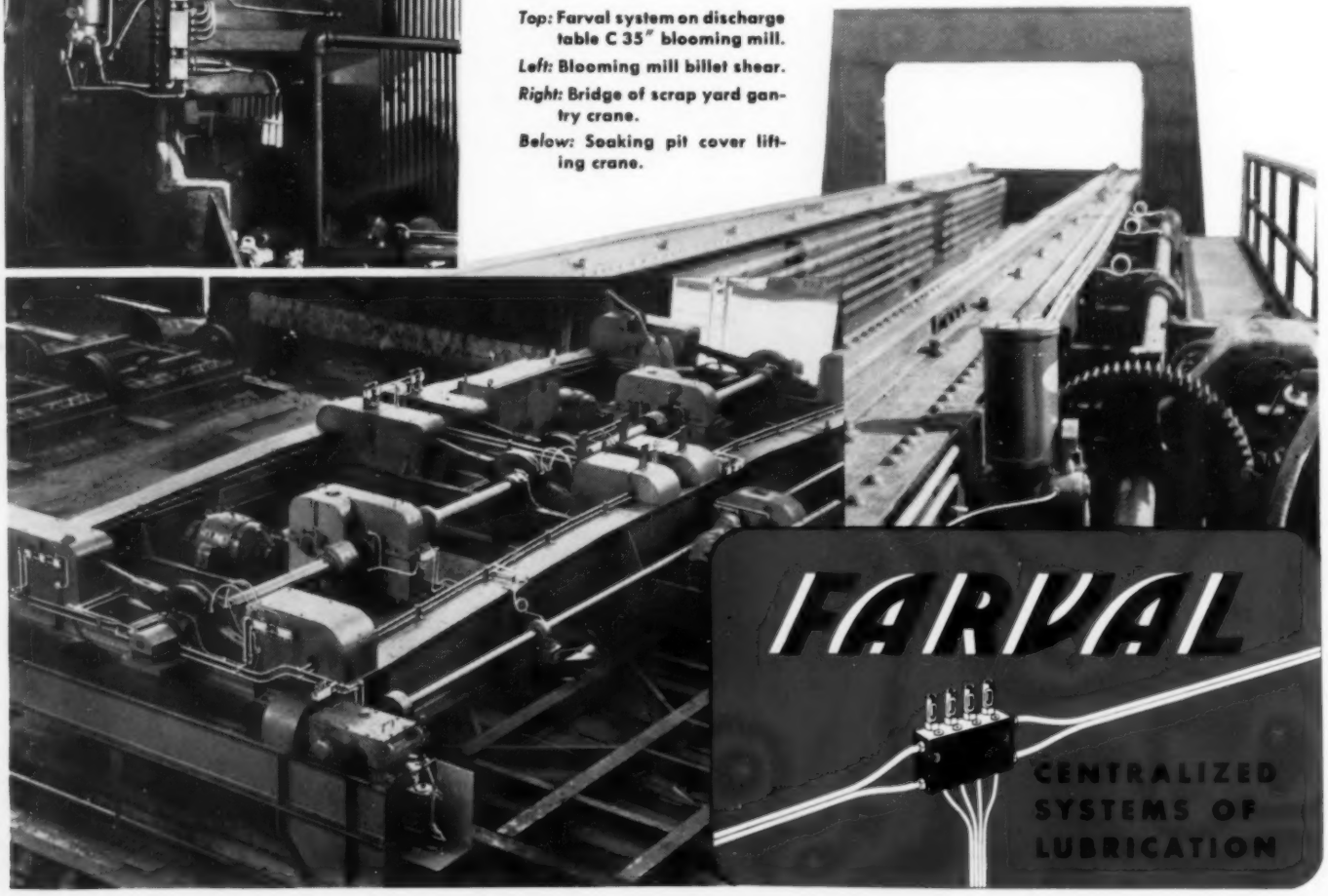
Cleveland Type CU drive is designed specifically for cooling tower service—rugged, efficient and compact. Built for continuous, trouble-free operation at high speeds and for long periods. Heavy, external ribbed housing effectively dissipates heat to air stream. Every unit is run in and pretested under load before it leaves the factory. Thousands now in service prove its reliability.

FARVAL protects thousands of bearings at Alan Wood Conshohocken Works



WHEREVER you go in the Alan Wood works, at Conshohocken or Ivy Rock, you'll see equipment protected by Farval Centralized Lubrication. Starting back in 1936, this company has made it standard policy to Farvalize because adequate bearing protection convinced management that this system of centralized lubrication saves 4 ways—in bearing expense, oiling labor, lubricant and production time. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Top: Farval system on discharge table C 35" blooming mill.
Left: Blooming mill billet shear.
Right: Bridge of scrap yard gantry crane.
Below: Soaking pit cover lifting crane.



THE NEXT FIFTY YEARS

. . . . address presented on April 3, 1951 before Chicago District Section of AISE . . . .

By JOHN H. VOHR
General Superintendent
Gary Works
United States Steel Co.
Gary, Ind.

JOHN H. VOHR

▲ LOOKING forward gives one wide latitude for the free play of imagination. It always has seemed to me that engineers, although matter-of-fact and practical about their day-to-day jobs, like to indulge in flights of fancy when thinking of the future. More than that, by their daily work they often have exceeded those wild flights of fancy in the developments for which they have been responsible.

By another coincidence, 1951 marks the hundredth anniversary of the first successful demonstration in America of the pneumatic converter by William Kelly —the beginning of the bessemer process, and of the age of steel.

In the following, let us consider some of the developments which might be expected during the next fifty years, and some of the things that we, as engineers, in the steel industry, might set as goals for the future. The principal thing that we should expect—in fact, be sure of—is change. I would be extremely rash if I were to try to predict tonight all the specific changes that may come in the next fifty years. But, I think I would be even more rash if I did not admit the inevitability of change. The entire history of all American industry, including our own, is one of change.

In 1843, a little over a hundred years ago, Henry Ellsworth, United States commissioner of patents, in a report to Congress said, "The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end." Many people, at the time, interpreted this as a prediction that the U. S. Patent Office would soon be abolished. "After all," they said, "every worthwhile invention has been patented."

Such an interpretation, of course, was extremely short-sighted. At that time, the open hearth process was unknown and even the bessemer process was only a gleam in the eyes of Sir Henry Bessemer in England, and William Kelly in the United States. The steel rail had yet to be made in America, and the vast Calumet region was still, for over sixty years, to be a wilderness of sand dunes. Henry Ford, Walter Chrysler, C. E. Kettering and other great automotive engineers were yet to be born. The horse-drawn vehicle was still the established mode of transportation.

I am sure that if anyone today were rash enough to say that the era of change in the steel industry is over, a few years would prove his remark to be as erroneous as was that of the patent commissioner in 1843.

Where will these changes occur? Well, there are several general areas.

First, I am sure, there will be continued technological improvement both in equipment and methods of steelmaking and shaping. Some of these improvements are already being adopted commercially; others are in the

laboratory stage; and still others are even now being discussed as possibilities for the future.

I can well recall, not so many years ago, our ideas of what might happen in the future. Some of these seemed pretty far-fetched to us at the time. I remember that we used to predict that some day we would be able to continuously coat tin plate in long strips rather than to dip each small sheet individually. Today, of course, the continuous strip mills and electrolytic tinning process have made a reality of yesterday's dream.

Numerous other instances may be cited of the visions of a few years ago which are the actuality of today. Thirty years ago or so when Walther Mathesius at South Works began to experiment with blast furnace burdens, there were many who thought he was tackling the impossible. Today the methods he proved in those experiments are standard operating practices. In addition, blast furnaces are bigger and technologically much better than they were then.

There is an amusing little sidelight on this constant change in the steel industry. It has to do with a believe-it-or-not phrase that has been dear to the hearts of steel men for many years. In our advertising, our radio programs, and our motion pictures, we have pointed out that the tin can is 98 per cent steel and only 2 per cent tin. Today, thanks to the electrolytic process, this statement no longer is literally true. For now many tin cans are 99¼ per cent steel and only ¾ of one per cent tin.

Sometimes we in the steel industry are prone to forget, just how many of the great changes in other industries have been dependent on steel-making processes.

Back in 1905, two years before the Association of Iron and Steel Engineers was formed, our first by-product coke plant was built at Joliet—designed to trap the smoke-laden riches of the coking process. From these coal chemicals today come a multitude of test tube marvels too great to list, sulfa drugs, novocain, aspirin, plastics, DDT, dyes and fertilizers, and the one that probably means the most to our wives, nylon hosiery.

One more outstanding development might be mentioned. It is one with which you are well familiar. That is the continuous rolling mill. Back at the turn of the century, one hand-fed sheet mill produced a half ton of steel in an hour. It was partially mechanized many years later and its output doubled. In contrast, one modern continuous hot mill has produced over 300 tons an hour on the average during the course of a year.

Yes, it is a safe prediction to make that there will be changes in steel technology. Four outstanding items under development are: (1) beneficiation of taconite; (2) pressurization of blast furnaces; (3) oxygen in the open hearth and (4) continuous casting. All of these are, of course, in various stages of development ranging from theory through pilot plant to actual commercial use.

I am sure that each of us could make up a list of many other fields in which technical progress is being made. We might mention, for instance, coal preparation. Deterioration of the quality of coal in recent years has been a handicap to blast furnace output. Coal washing has been one of the answers, but I am certain that other improvements will come in the future.

The sintering and nodulizing of ore has occupied the time and effort of many steel men. It helps to increase the metallic content of iron ores as charged and improves their physical condition. Thus, it is helpful in the operation of blast furnaces. Although much has been learned, and sintering capacity has grown to over 30,000,000 tons a year, it is still a field deserving of more study.

The American Iron and Steel Institute a little over a year ago listed some other fields of active research in which progress already is being made and in which more can be expected in the future. These include the search for palm oil substitutes; studies of mechanical properties of aircraft steels; methods of chemical analysis; desulfurization of fuel oil, and experiments in reworking slag with manganese content.

One of the dreams of metallurgists for many years has been the direct reduction of iron ore, and the elimination of the blast furnace. Up until the present time, although theoretically this is possible, no one has developed and placed into operation in a large way any direct reduction process as a commercially and economically feasible operation. The possibility always exists that under special circumstances and combinations of conditions, further use may be made of direct reduction processes.

The Sunday supplements these days are fond of pointing out that we are at the dawn of a new era—in fact, two eras—those of the electronic and atomic ages. Already electronics are figuring more and more in steel-making processes. For example, Geiger counters are used in some testing equipment, X-ray gages for determination of thickness, and radio-active materials to measure thickness of steels.

Many other electronic devices play a part in production, finishing and testing. At the moment no one knows what peacetime applications will come eventually from atomic experiments. However, it would be foolhardy to deny that some time in the future they will come.

So much for the changes that we may expect in technology. The second area in which I believe we shall find changes lies in the field of even more progress toward improved safety equipment and safety practices. This, one hardly needs to remind you, is a field dear to the heart of the iron and steel engineer. After all it was the Association of Iron and Steel Engineers which founded the National Safety Council. Personally, I am proud that it was in plants of our organization, United States Steel, that the slogan "Safety First" was born.

It was back in December 1908, when John C. Reed, then president of the Association of Iron and Steel Electrical Engineers, first appointed a safety committee. The safety program developed by this committee for meetings of the Association soon grew to be a dominating feature of these gatherings.

Four years later in 1912, the AISEE Safety Committee invited all industries to attend a Cooperative Safety Congress in Milwaukee. At this meeting a resolution was adopted urging the formation of a permanent organization for the promotion of safety. This resolution, often called the Magna Charta of the National Safety Council, was written by an engineer—Gano Dunn.

About two years ago, a Chicago newspaper reporter

in checking accident records for the various school districts discovered that fewer children were hurt in traffic accidents in schools in the steel mill district than in other schools in all parts of the city. Part of this unique safety record was attributed to the fact that safety training in the steel mills had carried over into the home.

The great improvement in the safety record in the steel industry over the past fifty years is something in which all of us can take pride. Today, steel is one of the safest of all industries. Yet I am sure that you will agree that there is still much to be done. The industry as a whole through its safety committees and the various companies in their individual plans all recognize this fact. In United States Steel, we are attempting to pin-point departments and specific job practices where improvements in safety methods can be effected.

This program is being carried out in accordance with sound engineering practice. In the foreword to a booklet describing this program, United States Steel Co. explains that

> "The field of safety offers the supervisor one of the best outlets in which to express his concern over the welfare of his fellow men, and it follows that the safety of those whom he supervises rates high on his list of duties."

The first step in approaching this problem is to get the facts. From them can be made a simple tabulation of the frequency of acts that are responsible for injury in each occupation involved. Second, when the facts are assembled, those occupations which show the greatest frequency of accidents will be spotlighted. Within these occupations, the act or acts responsible will come into focus. Having collected the facts and put our finger on the responsible acts, the next step is an engineering study of the job from which we single out our objectives—the establishment of a safe method of performance with reference to each of the acts.

Finally, when this has been done, corrective action is taken. The safe method of performing the act is determined. Possibly, also, it is found that additional guards on facilities or protective equipment for employes may be required. The individual employe is then instructed how to perform the acts safely. And still in keeping with sound engineering practice, control data is kept up-to-date to make sure that the objective is accomplished.

I think most engineers will agree with the soundness of this approach, as well as the truth of the company statement about this program which reads "no blueprint in itself ever put up a building. No safety plan in itself ever eliminated accidents. But planning can point out the way."

A third field in which I am sure we can expect change and improvement is in the development of new steels to meet new needs. Here again, the past gives us ample basis for the belief that change will continue in the future.

The automobile of 1951 would not have been possible with the steels of 1910 or even 1920. The car of today is heavier and has much more sweeping lines than its predecessor of the early thirties. Improvements in steel have played an important part in this development. In fact, cooperation between the steel industry and the engineers, metallurgists and other technicians of customer industries has been one of the greatest sources of advances in steel-making. Such products as cold reduced sheets, and new tin plate, were developed because of the demands for improved grades and types of steels needed in industries making containers, refrigerators, household appliances and automobiles. New methods of rolling steel and improved methods of making steel consequently followed.

Today's new industry—television—has been aided greatly by the development of a special steel for television tubes. The supersonic flights of jet planes are possible because of new alloys.

Another area of change which, I am sure, we can expect in the future is in the handling of industrial wastes. Here again, much already has been accomplished. Speaking in Hammond, Ind., last year, Dr. R. E. Zimmerman, chairman, research policy committee of United States Steel Co., discussed this subject at length, stating that for many years the greater part of the sewage polluting inland waters was from municipalities and that industrial wastes had accounted for only a relatively minor share of contamination.

"More recently," Dr. Zimmerman said, "comprehensive regulations have been promulgated applying to cities, towns and industries so that major as well as minor sources of contamination might be corrected. Under these conditions, industry is doing its share, contributing to the general clean-up in step with the others, and paying some very large bills to cover its share of the expense, with more to follow."

Speaking of atmospheric contamination, Dr. Zimmerman added, "Industry has been taking care of cases falling within this field. However, authorities are requesting that additional attention be devoted to the control of gases and particulate matter escaping into the air. Some enthusiasts have gone to extreme lengths in their recommendations, so much so that water vapor and nitrogen are about the only constituents of gases which have not been the objects of criticism. Industry may still be faced with some formidable projects which will tax severely both its ingenuity and its funds. In the steel industry alone, the handling of all condemned waste products, solid, liquid and gaseous, could require the expenditure of more than a few hundreds of millions of dollars for equipment installed, to which would be added the continuing expense of operating costs."

We can anticipate changes as well in capacity and output of steel in the coming years. But one thing that will not change is the steel industry's determination, in peace and in war, to meet the needs of the nation.

I think you are as familiar as I am with steel's accomplishments of the past several years in expanding output. Today, it is capable of producing 22,400,000 more tons of steel annually than it was when Hitler unleashed his goose-stepping hordes on Poland in 1939. In 1950 alone, steel capacity was increased by 4,837,000 tons.

Two months ago, the American Iron and Steel Institute estimated that "barring unexpected obstacles like materials procurement and financing, it is now likely that the 110 million tons a year goal will be approached by the end of 1951." This will be a year earlier than previously expected. Capacity of more than 117,-

500,000 tons a year will be achieved by the end of 1952.

Just last month, United States Steel broke ground for one of the major projects in its own expansion program—the new 1,800,000-ton capacity Fairless Works at Morrisville, Pa. Some of the equipment at this plant is expected to be in operation by the end of this year and the goal for the completion of the entire project is set as the end of 1952. The 1,800,000 tons capacity does not make this mill the largest in the country. There are, in fact, three larger in the Chicago district. But it is the largest integrated mill ever built at one time.

Among the products which will be produced at this new plant are carbon, high strength, and alloy steel ingots, blooms, billets, slabs, bars, including bar sized shapes, rounds, squares, concrete reinforcing bars, hot and cold rolled sheets and strip, vitrenamel sheets, black plate, electrolytic and hot dipped tin plate. All of these products will be produced by United States Steel Co. National Tube Co., another United States Steel subsidiary, will produce standard pipe. The coke plant, which includes two 87-oven by-product coke batteries, will produce 916,000 tons of coke annually, plus important tonnages of coal chemicals, including light oils and ammonium sulphate, crude naphthalene and tar.

Some breakdown on the annual capacities may be of interest. They will include 289,000 tons of cold rolled sheets; 235,000 tons of hot rolled sheets; 281,000 tons of standard pipe; 285,000 tons of bar products; and 170,000 tons of tin mill products. In addition to the coke ovens, the facilities include two blast furnaces; nine open hearth furnaces; an 80-in. hot strip mill and hot strip finishing facilities; finishing facilities for cold rolled sheets and tin plate; a bloom-slab mill and auxiliary facilities; a billet mill and auxiliary facilities, and a bar mill with a size range from $\frac{3}{8}$ to 2-in. Total employment at the new plant upon completion is expected to be 4,400 production workers, exclusive of clerical and management staff.

Eventually, it is expected that the new plant will utilize a part of the high grade iron ore which Orinoco Mining Co., another U. S. Steel subsidiary, plans to mine from its iron ore properties in eastern Venezuela. Until such time as this ore is available, the new Fairless Works will utilize other foreign ores as well as domestic iron ore.

So much then for the changes we may expect in the future. For the remainder of our allotted time let us briefly consider what we as engineers might set as goals for ourselves in meeting those future changes. There are many that might be suggested, but tonight I would like to emphasize only two.

The first of these is that each of us should desire to work toward greater proficiency and progress in the field of human relations. You may ask why bring this subject up at an engineering meeting? Well, engineers have already contributed much in this field. The accomplishments of your organization in safety, an important part of human relations, already have been mentioned.

At the National Education Association convention in Atlantic City a few weeks ago, Dr. L. A. Wilson, commissioner of education for the State of New York, said that few people in industry fully appreciate or understand the contributions of industry, its technicians and engineers, to the industrial revolution of the last half century. Or, he added, to put it in another way, what that industrial revolution has meant in terms of human values. The big fact that he stressed was the substitution of electrical and mechanical energy for human energy, the transferring of man's load from his back to the machine.

I can recall that when I entered the steel industry, the twelve-hour day was common. Today, we have the forty-hour week, with man's age-old goal of leisure achieved, not by a chosen few, but within the grasp of all.

And so all of us, I think, might take Dr. Wilson's advice to heart. We can strive for a better understanding of the service which our industry and all industry has rendered to mankind—a better understanding not only on our own part but on the part of others.

Human engineering may never become as exact a science as electrical and mechanical engineering. However, great progress is being made in the field of communications, training, job evalution and kindred lines. And it's a field that should offer a challenge to bring forth our best thought and our most earnest and wholehearted effort. There may have been a day in the past when an operating executive's only duty was to maintain production. But today every supervisor, be he foreman, plant superintendent or operating vice president, finds himself occupied more and more with problems of human relations.

It is a truism that the essential ingredient for successful defense of our nation in war or for prosperity in times of peace is productivity. Productivity, we are told over and over again, depends upon men, machines and material. We have gone far in developing two parts of our productivity equation—materials and machines. The third factor of the equation is men.

Our system of government differs from the totalitarian in the emphasis that it places on the individual. A man's attitude toward his job, his ability to get along with his fellow workers and his understanding of the opportunities afforded by an industrial system based on private initiative under a free government, are important to productivity. Yes, gentlemen, the subject of human relations—of people, is one that deserves the attention of all of us.

My other suggestion is along the same line. It also has to do with people. It is that you continue to swap experiences, ideas, and yes, dreams for the future with others in the same line of work. Frankly, I think that the interchange of ideas possible in an informal or a formal meeting is one of the best ways that any of us can prepare ourselves for what lies ahead in the next fifty years. And as to what does lie ahead, I think there is no better conclusion than one stated in a recently published school textbook called, "The Conquest of Steel," by Charles Manwiller and Margaret Maloney. At the end of this book, written for grammar school children, I found these two paragraphs:

> "We will not learn overnight to use atomic energy as we wish. But some day, perhaps, we will really send the rockets to the moon and let our space ships travel between the stars the way it is now told in fairy tales.
>
> "We can be sure that if we ever do manage to make these dreams come true, it will be in part through the magic of iron and steel."

Density Control

OF COAL CHARGED TO COKE OVENS

By

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. . . . bulk density control, using about one pint of oil per ton of coal, gives remarkable results in smoothing oven operation . . . .

▲ A NUMBER of papers have been published dealing with additions of oil to coal in some manner and for some particular purpose. One of these, a paper presented by C. J. Ramsburg and G. V. McGurl before the American Gas Association in 1940, discussed two different aspects of oil addition. One deals with the addition of large amounts of oil in order to increase gas yields, the other with the addition of small amounts at the mines to increase bulk density and to control moisture, dust and weathering. Another paper by P. C. Mayfield, presented before the American Iron & Steel Institute, in May 1947, deals primarily with the addition of large quantities of oil to increase gas yields. The U. S. Bureau of Mines also has reported the results of several investigations. A Russian article in STAHL, pp. 533-537, 1946, by Agroskin and Gregor'ev, claims that an addition of 0.1 to 0.2 per cent of coal-tar oils increases production 5 per cent and that after 1½ years of experimentation this is now standard practice at one Russian coke plant. They further point out that coking of increased density charges does not require increased temperature or lengthening of coking time.

Claims for increased light oil and tar production in this latter article can be discounted because of the use of increased percentages of gas coals in most of the mixtures.

The primary purpose of this paper is somewhat different. The intention is to show from actual experience what can be accomplished in bulk-density control by the careful addition of oil and water at a coke plant and to indicate the limitations of such control.

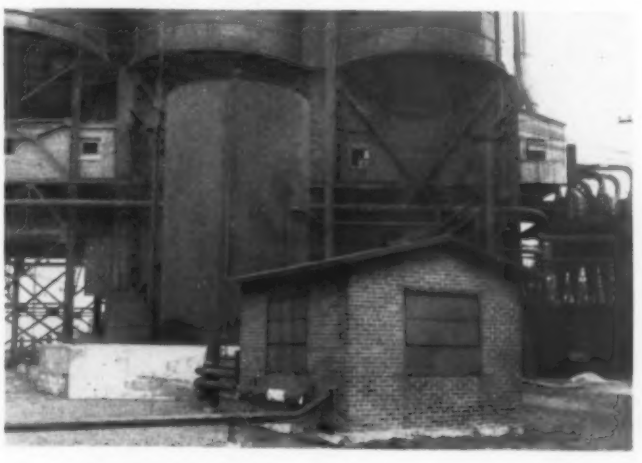
The chief causes of variations in bulk density found in normal coke-plant operation are differences in the degree of pulverization and in the moisture content of the coal. At the Sparrows Point plant of Bethlehem Steel Co., it was found that an increase in the degree of pulverization from 60 to 80 per cent through a ⅛-in. mesh screen decreases the bulk density of the coal approximately 6 per cent. Experimental work has likewise shown that the addition of water to finely pulverized dry coal will decrease the bulk density, the maximum being 15 per cent at 7 per cent moisture content. Above 7 per cent moisture the weight per unit increases as water is added.

The effects of variation in bulk density of the coal mixtures charged to the ovens are well known. A decrease in density means less coal per charge and a consequent loss in coke tonnage. An increase in density means an increase in pressure on the oven walls during the coking cycle. If the increase is sharp, it may result in a coke that cannot be pushed and there may be serious damage to the oven walls.

Following are some figures showing the effect of bulk density on maximum pressures developed during coking in Bethlehem's 10-in., movable-wall, experimental oven.

Four tests on a plant mix having a density of 43 lb showed a maximum pressure of 0.8 psi, whereas the

Figure 1 — In foreground is small pumping station and in background is oil storage tank.



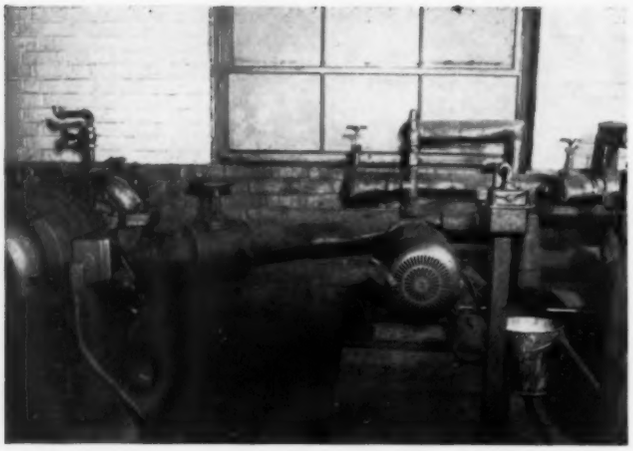


Figure 2 — Interior view of pumping station with unloading pump on left.

Figure 4 — In foreground is shown control building. Crusher building is shown in background.

same mixture at a density of 53 lb developed a maximum pressure of 2.0 psi.

Koppers and Jenker in FUEL, page 232, 1931, give the following data:

(*Dry*) *Bulk density, lb/cu ft*	*Maximum pressure, psi*
49.9	0
50.8	1.42
57.0	4.27
60.1	14.22

A great deal of data could be assembled showing the effects of various densities on oven pressure, but the above are sufficient to indicate clearly that marked increases in the density of the coal charged may be dangerous.

It should also be pointed out that in addition to affecting the coke tonnage, a variation in bulk density also affects the quality of the coke and the efficiency of the operation. No heater can do a good job in producing a uniform coke or in heating economically if the bulk density is subject to wide swings.

When the effects of variations in density are clearly understood, each operator must decide for himself whether or not it would be advisable to control the bulk density in his particular plant.

In our opinion, bulk-density control could be advantageously employed in many plants where it is not now practiced. The reasons for this reluctance are probably the uncertainty as to how the job should be done, how well it can be done, and what physical equipment is required. The remainder of this paper, therefore, will be a description of the operating procedure, the equipment, and the results of the bulk-density control system installed in the coke works at the Sparrows Point plant of Bethlehem Steel Co.

Figure 3 — Sweep sampler takes coal for all tests.

The use of an effective bulk-density control system places an important device in the hands of the coke-plant operator in that it enables him to adjust his oven coal charge to meet changing conditions of coal source, degree of pulverization, moisture content, and battery operating conditions. The desired control weight figure must be arrived at by the responsible operator, based on coal blend at the time, coking rate, condition of oven walls, height of ovens, and minimum moisture content. It is even feasible to operate a plant having several batteries with two control weights, where for reason of oven condition or coking rate, a lighter bulk weight to certain groups of ovens provides a safety factor without penalizing the capacity of the entire plant.

Since dry coal has the highest bulk density, bulk-density control could be accomplished by water addition alone if a plant could depend upon all of its coal remaining under the minimum moisture content required for safety. When the moisture rises above this figure, however, oven charge weights suffer and coke production is lost. The use of oil will restore these weights in full up to 5.5 per cent moisture at 80 per cent pulverization. Above 5.5 per cent moisture, the percentage regained diminishes due to excessive wetting.

At the Sparrows Point plant the installation of a control system was a necessary adjunct when the coal pulverization was increased from 60 to 80 per cent

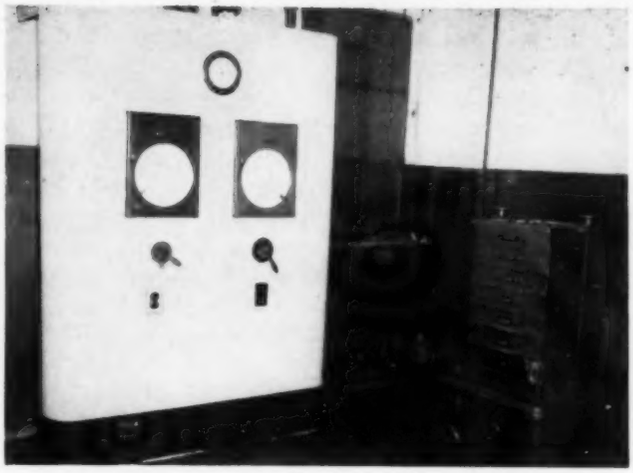


Figure 5 — Interior view of control building.

Figure 6 — Drying oven is shown on left. This unit is located inside the control building.

through ⅛-in. mesh. If the weight had not been restored, there would have been a loss of approximately 3000 tons of coke per week. This tonnage would have had to be replaced through the purchase of outside coke at a high differential cost. Equipment, therefore, was installed to restore the original bulk density and to achieve uniformity in charging and heating practice.

The bulk density practice is set up to regulate moisture at approximately 5 per cent and to maintain a weight of 44.0 to 44.5 lb per cu ft by ASTM box test. The oven density corresponding to this test density is 50.0-50.5 lb per cu ft, the gain being due to packing resulting from the height of drop from the larry car to the oven. This same coal, untreated, would have an oven density of only 47.0 to 47.5 lb per cu ft, a net loss of approximately 7 per cent. The quantity of oil required to restore this bulk density is only 0.16 gallons per net ton of coal treated. When the moisture exceeds the 5 per cent control moisture the oil rate must be increased to maintain this density, and will increase to a maximum of 0.3 gallons per ton of coal at 6 per cent moisture. With this oil there is no coal condition that would require a greater consumption of oil at this control density, because in this moisture range, any additional oil would decrease the density.

To operate the system an operator is on duty at all times the coal-handling plant is operating. His job consists in checking hammermill performance by running screen analyses on the crushed coal, regulating moisture by making periodic determinations of snap samples, and controlling bulk density by oil adjustments. The minimum amount of testing done is two screen analyses and four moisture analyses per eight-hour turn and hourly determinations of bulk density. Moisture tests are made more frequently as variations in the coal require it. Changes in the bulk density provide the guide to the adjustment required. If the density drops, it is an indication that the moisture has increased; unless water is being added to the coal, the quantity of oil must therefore be increased. If the density shows an increase, it indicates that the moisture is reduced and must be restored by water addition. These conditions are true if the pulverization has shown no marked change. Minor variations in weight can be attributed to shifts in the distribution of intermediate-sized coal in the prepared product. It should be apparent that in an intermittent control such as this, 100 per cent continuous uniformity is not practicable at this point. However, greater uniformity is obtained at the ovens because the reduction of variation in the coal accomplished at the coal plant is reduced by the mixing of the coal upon entering the storage bins above the ovens.

To do this job properly, three things are absolutely essential:

First: There must be suitable equipment and apparatus.

The following figures give a general description of the installation.

Figure 1 shows the small pumping station housing the unloading pump and the oil pumps to the system, with the oil storage tank in the background.

Figure 7 — Oil and washer lines lead to sprays over the blended coal.

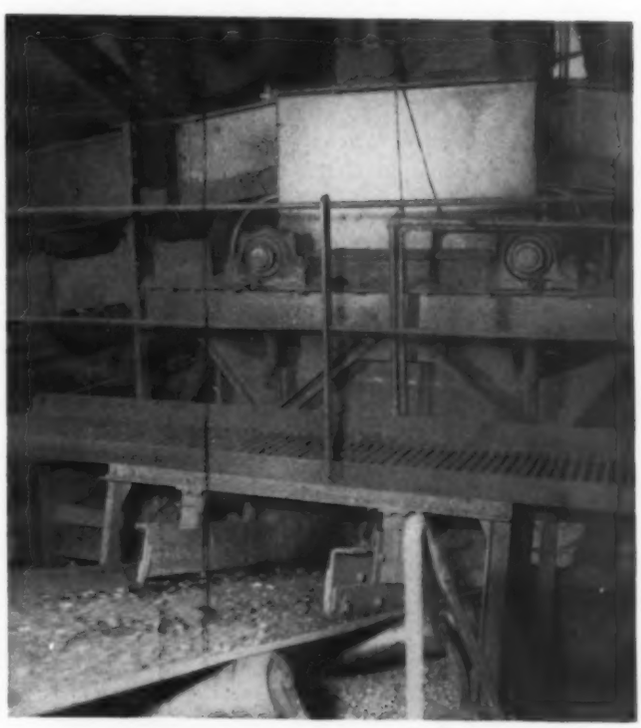


Figure 8 — Oil line enters hood of dust collecting system where it sprays oil on the blended coal.

Figure 2 shows the interior of the pumping station with the unloading pump on the left and one of the two system pumps on the right.

Figure 3 shows the sweep sampler which takes the coal for all tests.

Figure 4 shows the control building with the crusher building in the background and the conveyor from the crushers on the right.

Figure 5 is an interior view of the control building showing the oil flow meters and controls on the panel board, the water meter in the center background, and the screen equipment on the right.

Figure 6 is another interior view showing the drying oven on the left and the apparatus for moisture determination on the right.

Figure 7 shows the oil and water lines leading to the sprays over the blended coal on the way to two of the hammermills.

Figure 8 shows the oil line entering the hood of the dust-collecting system to spray oil on the blended coal going to the other two hammermills. The water connection for the coal to these two mills is on the opposite side.

Second: The character of the oil used is extremely important.

In general, where oil treatment of coal has been tried, too little attention has been paid to the quality of the oil. In selecting the oil for this particular installation many different types were tested. Bunker "C" grades are definitely not recommended. To do the same job as a good coal spray oil, required one- and one-half times as much Bunker "C." This cancels the cheaper price. It has the further disadvantage of requiring considerable heating to pump it freely to the coal. Even then, it does not mix intimately with the coal particles, but tends to "ball." It is also a dirty oil to handle and would necessitate frequent tank cleaning as well as

Figure 9 — Table gives coal preparation data for the month of March 1946.

Date (1946)	Coal Charged per Day N.T.	Pulverization % -1/8"	Oil and Water Added Daily				Average % Moisture in Coal as Charged	Bulk Density (lbs./cu.ft.) of Coal as Charged
			Water		Oil			
			Total Gallons	Gallons per N.T.	Total Gallons	Gallons per N.T.		
Mar. 1	8753	81.3	81	.00925	802	.196	4.88	44.1
2	8753	81.0	2161	.2465	1506	.172	5.16	43.9
3	8825	81.1	0	0	1120	.127	4.93	43.8
4	8752	83.1	0	0	1875	.214	5.28	43.9
5	8814	79.1	0	0	1978	.224	5.22	43.9
6	8835	80.8	0	0	2141	.242	4.91	44.0
7	8840	89.4	0	0	2437	.276	5.41	44.0
8	8858	80.1	0	0	1350	.156	4.97	44.3
9	8886	80.5	300	.0380	1060	.119	5.06	44.3
10	8880	79.6	74	.0084	1130	.127	5.13	44.4
11	8878	88.0	0	0	1847	.208	5.13	44.4
12	8824	79.6	0	0	1250	.142	4.94	44.1
13	8887	77.9	8993	1.03	1344	.151	5.06	44.0
14	8879	79.4	9362	1.055	1262	.142	4.81	44.1
15	8666	78.9	11449	1.325	848	.010	4.53	44.5
16	8340	82.2	0	0	942	.013	4.94	44.1
17	8786	81.3	0	0	760	.009	4.88	44.1
18	8786	81.6	8350	.950	855	.010	4.66	44.3
19	8878	80.4	7671	.820	827	.009	4.78	44.2
20	8878	81.2	5639	.635	916	.010	4.63	44.1
21	8858	80.9	7040	.825	1073	.121	5.06	44.1
22	8716	81.8	0	0	1101	.126	5.16	43.5
23	8426	82.0	2481	.241	1363	.162	5.41	43.8
24	8172	77.9	0	0	2060	.252	5.44	43.9
25	6737	76.8	0	0	1183	.176	5.28	44.0
26	6688	80.7	1343	.206	1269	.190	5.25	44.3
27	6686	83.4	1679	.253	1740	.260	5.56	44.3
28	6683	79.1	5198	.777	966	.145	5.03	44.2
29	6695	80.5	1970	.295	1266	.189	5.22	44.2
30	6669	78.3	935	.139	745	.112	4.97	44.1
31	6675	77.6	785	.117	937	.140	5.34	44.1
Average		79.9				.164	5.07	44.1

periodic cleanings of pipe lines, valves and sprays.

Coke-plant operators are inclined to follow the line of least resistance and use wash oil. Even fresh wash oil has comparatively small penetrating power, which prohibits its use on the basis of price alone. Of all the oils tested, a cold spray oil of the following specifications was found to be the most satisfactory:

Naphthalene base

Specific gravity	0.931
Viscosity	200-210 Sec @ 100 F Saybolt
Pour point	0 F
Flash — Open cup	335 F
Fire point	370 F

Distillation — Vacuum Engler

F.D.	255 F
5	347 F
10	375 F
20	403 F
30	417 F
40	431 F
50	445 F
60	463 F
70	479 F
80	500 F
90	527 F
95	550 F
E.P.	567 F

This is a clean oil, has good viscosity over a wide range of temperatures, requiring heating only in very cold weather, and has exceptionally fine penetrating power, which makes it ideally suited for this purpose.

Finally: Intelligent supervision is required at all times.

Bulk density control is either necessary or it is not. If it is necessary then no occasional check by any individual who has other work elsewhere will answer. There must be constant attention from an operator to realize the economy of uniform and maintained oven charge weights, minimum oil consumption, reduced variations in coal moisture and protection from excessive oven densities. Any system set up to add a constant amount of oil to the coal is wasteful, does not control, and can be dangerous on blends where high density must be avoided. The necessity of having a high-class operator in attendance at all times has been well established by our experience.

If these three prime requisites of a first-class job are met, results similar to the following can be expected in any plant.

Before the control system was placed in operation, variations were as much as one ton per coke oven charge, reflecting changes in moisture. Since control was established, the variation has not exceeded 0.10 ton. The

Figure 10 — Extremely good operation is shown in this daily report.

EXHIBIT H-2

D 600-1,500-8,49-BSCo

BETHLEHEM STEEL COMPANY
Sparrows Point Plant—Coke Oven Department
COAL PREPARATION REPORT

OPERATOR: 7-3 ..... 3-11 ..... 19...

TIME	A.M. 4	A.M. 5	A.M. 6	A.M. 7	A.M. 8	NOON 9	P.M. 10	P.M. 11	P.M. 3	P.M. 4	P.M. 5	P.M. 6	P.M. 7	P.M. 8	P.M. 9	P.M. 10
HAMMER MILLS OPERATING	1-2-3	1-2-3	1-2-3	1-2-3	3-4	3-4	3-4	3-4	1-3-4	1-3-4	1-3-4	1-3-4	1-3-4	Idle	1-3-4	1-3-4
BULK DENSITY	12 44	4 44	2 44	5 44	3 44	15 44	2 44	5 44	4 44	4 43	5 44	9 44	1 44		2 44	4 43
MOISTURE %	4.75		5.00		5.25		4.75		5.00		5.00		5.25		5.25	Avg. 5.03
SCREEN ANALYSIS + ¾" %		0		0		013				0			0			
SCREEN ANALYSIS + ½" %		0.3		0.3		0.3				0			0.2			
SCREEN ANALYSIS + ¼" %		4.4		4.0		5.3				3.2.			3.5			
SCREEN ANALYSIS + ⅛" %		16.3		15.6		17.2				15.0			15.3			
SCREEN ANALYSIS Thru ⅛"		79.0		80.1		76.9				81.8			81.0			
WATER RATE Gals. per min.	0	0	0	0	0	0	12	12	10	10	0	0	0		0	0
OIL RATE Gals. per hr.	60	45	60	55	65	65	45	45	50	50	50	50	50		60	120
OIL TEMP. °F.	128	128	124	126	126	126	124	126	122	126	126	126	126		126	126
OIL PRESSURE # per sq. in.	100	100	100	100	100	100	100	100	100	100	100	100	100		100	100

OIL USED: Meter Readings

Off 626274
On 625471
Diff. 8.03

WATER USED: Meter Readings

	Crusher	Breaker
Off	5597213	
On	5594282	
Diff.	2931	

STORAGE TANK MEASUREMENT
7:00 A. M. ..... in.

REMARKS .....

EXHIBIT H-2

D 600-1,500-8,49-BSCo

BETHLEHEM STEEL COMPANY
Sparrows Point Plant—Coke Oven Department
COAL PREPARATION REPORT

OPERATOR: 7-3 .....
3-11 .....
..... 19 ....

TIME	A.M. 7	A.M. 8	A.M. 9	A.M. 10	A.M. 11	NOON 12	P.M. 1	P.M. 2	P.M. 3	P.M. 4	P.M. 5	P.M. 6	P.M. 7	P.M. 8	P.M. 9	P.M. 10
HAMMER MILLS OPERATING	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4	3-4
BULK DENSITY	44-13	46-1	45-10	43-12	45-6	43-2	44-3	44-7	45-8	45-1	43-8	45-8	44-5	45-5	46-3	45-1
MOISTURE %		4.00		4.50		4.50		4.25		4.50		4.50		4.75		4.50
SCREEN ANALYSIS + ¾" %		0				0				0				0		
SCREEN ANALYSIS + ½" %		0				0				.3				0		
SCREEN ANALYSIS + ¼" %		5.0				4.4				4.7				4.4		
SCREEN ANALYSIS + ⅛" %		15.3				14.4				15.6				14.4		
SCREEN ANALYSIS Thru ⅛"		79.7				81.2				79.4				81.6		
WATER RATE Gals. per min.	9	9	14	0	0	0	8	8	8	12	12	12	13	7	12	14
OIL RATE Gals. per hr.	90	90	75	85	90	90	110	110	118	105	105	125	110	120	110	90
OIL TEMP. °F.	132	94	86	92	86	84	84	84	84	90	86	82	86	84	84	86
OIL PRESSURE # per sq. in.	96	96	96	96	94	94	94	94	94	96	94	94	94	94	94	96

OIL USED: Meter Readings

Off ..... 54400 .....
On ..... 52952 .....
Diff. ..... 1448 Gals.

WATER USED: Meter Readings

	Crusher	Breaker
Off	298134	
On	291187	
Diff.	6846	

STORAGE TANK MEASUREMENT
7:00 A. M. ..... in.

REMARKS .....

Figure 11 — Operation will seldom fall lower than indicated by this daily report.

following comparison of monthly average charge weights on a battery of ovens is significant:

Before control, net tons

October 1945	18.84
November 1945	19.05
December 1945	18.93
January 1946	19.06
February 1946	19.33

After control, net tons

October 1946	19.40
November 1946	19.38
December 1946	19.38
January 1947	19.39
February 1947	19.39

The day-to-day variations were more drastic on the untreated coal than the monthly averages. The second column represents finely pulverized coal. If this were untreated, the effect on weights would be even more severe, because the effect is more pronounced as the fineness of the coal increases.

Figure 9 shows a daily summary of the operation for the month of March 1946. Of particular significance is the fact that while there were wide variations in the amount of water and oil added daily, there was a striking uniformity in bulk density and oven weights charged.

Figure 10 shows a representative report of a single day's operation. This was selected because it shows operation at its best.

Figure 11 is a similar report showing operation at its worst. A study of the variations in the amount of oil and water added indicates the wide swings in moisture content with which the operator had to contend. It takes only a little imagination to realize how much wider the bulk-density range would have been had there been no control.

The story on density control would not be complete without stating briefly what other effects the oil has.

In handling fine wet coals, the operating difficulties are well known to all operators. Wet coal tends to clog in bins and larry hoppers, making operation difficult. It adds to the labor in the batteries and hinders good charging practice. Since treatment with oil was begun, there has been no plugging anywhere in the coal-handling system unless the moisture content was above 6 per cent. Even in high moisture ranges, oil minimized the difficulties encountered in handling wet coal. The oil imparts free-running characteristics to the coal, greatly improving the larry loading to more uniform weight and reducing to a minimum oven charging time. At the plant under discussion, production was frequently lost before control was initiated because of plugging of bins and hoppers.

The effect of oil treatment on carbon formation has not been established. It is not likely that the small amount of oil required would make any difference. Even though the oil would tend to decompose at a lower temperature than the volatile matter in the coal, a moisture content of 5 per cent should neutralize any adverse effects.

The quantity of oil added for density control is so small that no measurable increase in coal chemical yields or Btu value of the gas can be found.

In summary, it still looks to us almost like a minor miracle what can be accomplished in bulk-density control, with consequent uniformity in oven operation, by the intelligent addition, in a properly designed system, of approximately one pint of oil per ton of coal.

DISCUSSION

PRESENTED BY

C. C. RUSSELL, Research Department, Koppers Co., Inc., Pittsburgh, Pa.

J. P. GRAHAM, Metallurgical—Research and Development Division, Republic Steel Corp., Cleveland, Ohio

J. K. KURTZ, Superintendent Coke Ovens, Bethlehem Steel Co., Sparrows Point, Md.

C. R. MONTGOMERY, Chief Chemist, By-Product Coke Department, Pittsburgh Steel Co., Pittsburgh, Pa.

E. C. KENNEDY, Superintendent, By-Product Coke Plant, United States Steel Co., Gary, Ind.

N. ISENBERG, Chief Chemist Coke Plant, Inland Steel Co., East Chicago, Ind.

C. C. Russell: As a matter of historical interest, the discovery of the effect of oil on the bulk density of coal came about in connection with an interest in the protection of coal from weathering by the addition of a small amount of oil. Two 1000-ton batches of a high-volatile coal had been shipped to one of our plants, one treated with one gallon of oil per ton and one untreated. The program was to use a portion of the fresh coal in a blend with the other coals in the plant to determine the coking properties and place the rest of the coals in storage for a six-month period. After storage, the tests were to be repeated. Four oven charges containing the fresh untreated coal were put into the ovens with no noticeable change in the oven charging weights. However, when the oil-treated coal blend was charged, the weight of coal in the full larry car was almost 15 per cent higher than the unoiled coal. This unusual behavior was immediately checked with the same results and the use of oil for bulk density control has developed from that beginning.

Small amounts of oil for bulk density control have been used at our plants for about 10 years in substantially the same manner as described by Mr. Stahl and Mr. Kurtz. The aim of the work has been to maintain constant weight of coal charge to the ovens, and this has been accomplished. Regular testing of the bulk density of the coal going to the oven bins is carried out, and the amount of oil is adjusted according to the bulk density determinations. Our company has recently designed a completely automatic apparatus for determination of bulk density and regulation of oil and/or water so that no manual attention of this operation will be required.

It might be well to point out that the function of oil in controlling bulk density is in connection with the water that is on the surface of the coal particles. Water that is held within the particles of coal does not affect the bulk density, and, consequently, the addition of oil has no effect. As an example, during the war one of the coke-oven plants using a low-rank coal having about 6 per cent moisture was desirous of increasing oven capacity. Experiments with the addition of oil to this coal were unsuccessful because there was substantially no surface moisture. The actual findings showed a slight decrease in the bulk density due to the addition of oil.

It will be well to re-emphasize the point made in the paper that application of oil for bulk density control must be made only under carefully controlled conditions. Small increases in bulk density can cause large increases in carbonization pressure, resulting in stickers and oven wall distortion or damage. Tests of the coal mixture for carbonization pressure should be made at the increased bulk density.

The authors have presented an excellent description of a simple and inexpensive method for controlling bulk density and improving coke-oven operation. Such improvement must be reflected in the uniformity of the blast-furnace coke and should aid materially in the uniformity of blast-furnace operation.

J. P. Graham: Republic has been using oil on coal for a number of years, but for purposes other than bulk density control. The treatment has consisted of the addition of 0.1 gal per ton of coal at the mine. During the past five years, at our Cleveland Plant, the pulverization through $\frac{1}{8}$ in. screen has increased from 72 to 79 per cent, while the moisture content has increased from 3.8 to 5.7 per cent. However, since the tons of coal charged per oven are still about the same, it is apparent that the coke plant is now charging more coal per oven than would be possible if the coal were not oiled. Monthly averages of the "tons of coal charged per oven" indicate that there is considerable variation in the bulk density of the coal charge, signifying that, as Messrs. Stahl and Kurtz have pointed out, merely adding oil will not stabilize bulk density unless the proper methods for control are exercised.

Test oven experiments made by our research department on charges of varying densities have indicated that the tumbler stability values of the cokes produced are not particularly affected by density changes. However, higher charge densities tend to increase the apparent specific gravity of the coke, indicating reduced porosity of the coke structure. Is denser coke desirable for the most efficient blast furnace operation?

The advantage of uniformity in blast furnace coke is indisputable and bulk density control of coal charges will contribute toward coke uniformity. The control method described by Messrs. Stahl and Kurtz should certainly be considered by coke plant operators who are now using a high percentage of pressure-expanding coal or those who need to increase the amount of low volatile coal to improve the strength of their coke. Before others could completely assess the value of bulk density control, it would be necessary to know how

much improvement in blast furnace practice is realized by the improved uniformity of the coke.

J. K. Kurtz: We do not have any statistical evidence to the effect that blast furnace performance is improved by bulk density control. Our approach has been this:

There is considerable difference of opinion as to whether, for a given operation, a blast furnace requires a definite volume of coke or a definite weight. In our plant, not knowing the answer, we still assume that the weight is the important factor. In planning to go from 60 to 80 per cent pulverization, we knew we would lose 3000 tons of coke per week. Generally speaking, this coke could be replaced only with inferior coke at a high differential cost. The primary purpose of our bulk density control therefore was to restore the weight lost by finer pulverization.

The net result of the two changes, finer pulverization and bulk density control, which were made simultaneously, is that there is a definite improvement in the physical characteristics of the coke as indicated by shatter and tumbler tests and reduced breeze production. We cannot say what proportion of this improvement is due to finer pulverization and what proportion to uniformity in charges.

C. R. Montgomery: We have been using oil on our coal for bulk density control since 1947 and I should like to concur in almost everything Mr. Kurtz has said. Our reasons for having a coke plant is to make coke for our three blast furnaces, one of which was acquired since the erection of the coke plant. Our carbonizing capacity is only enough to take care of the two small furnaces, or the large one and part of one of the others. This means we must at the present time purchase 800 to 1000 tons of coke per day to operate our furnaces at capacity, and you know the cost of coke bought on the outside today.

By using oil on the coal, we have increased our coke to the furnace by better than 100 tons a day, which amounts to a considerable savings over buying this coke. We do not have the elaborate testing procedure that Mr. Kurtz has for maintaining a close check on our bulk density, since we charge only 15 per cent of the low volatile Pennsylvania highly expansive coals. We are adding about 0.17 gal of oil per ton to our 5 per cent moisture coal, which gives us roughly an increase of about 8½ per cent of coal to the ovens over our previous charges without oil.

I feel another important thing in adding oil to the coal is that the coal does handle much easier, particularly in the bins and larry car. The boys do not have to pound the larry to make it run as they used to.

In controlling our bulk density, we find you can pretty well fix the rate of oil additions, but our big variable is in controlling the water addition when our coal is below the moisture content just mentioned.

E. C. Kennedy: These plant results pretty well speak for themselves, since they show a very good job of control. The need for this type of control, for us, is probably more evident than in their plant.

We do not control bulk density, however, we do charge 65 per cent Pocahontas, and, as you know, the expansion pressures get quite high, especially varying from mine to mine in that particular type of coal.

We have found that a bulk density of 44½ pounds, which is in the neighborhood of what Mr. Kurtz is using, will normally give us approximately ½ psi, as attested by Mr. Russell's oven, while that same mix at 51 lb bulk density gives a peak expansion in excess of 3 pounds, which is, of course, considered in the zone where it will create damage. That condition is still further aggravated, and it was with us, when we went to washed Pocahontas coal, as we got a reduction in ash and we also got considerable increase in expansion pressure. The ash acting as an inert material keeps your pressure down. For that reason, when they had the mines add some oil to increase the bulk density, back in the zone where we formerly used it, we did end up with considerable stickers and we had to lower the amount of oil.

At that time we were adding two quarts of oil per ton of Pocahontas, or approximately slightly greater than 0.25 gal per ton to the coal as charged. When we added that amount of oil, we did not find any measurable results in calorific value of gas or light oil produced, and we were not able to chart any noticeable changes in carbon in the ovens.

We have one question which comes to our mind as we run coal moisture in our laboratory. We dry them for an hour at approximately 105 C, and the determination of moisture takes approximately 1¼ hours to 2 hours. I am sure that Mr. Kurtz is not using that type of method for determining moistures, in order to go back and use it for a control. Our question is: What rapid method for determination of moisture are you using so that you can use the information for control purposes?

Then we have another question and what we want to know is: Have these additions of oil on the conveyor belt caused any change in the life of the belt, especially those that are not synthetic rubber?

J. K. Kurtz: Mr. Kennedy, to answer your second question first, our system has been in operation 3½ years, and coal belts, as you know, last so long that it is a little difficult to tell. We have changed only one belt in that time, but that happens to be a coal belt, so we do not know. We have not seen any evidence that this small amount of oil does affect the rubber at all. Others who have used oil longer say that the effect of small quantities is negligible.

As to moisture determination, to have effective control the method must be accurate and quick. A very accurate method that requires only 12 minutes is to add 250 cc of xylol to 250 grams of coal and distill off the xylol and water.

C. C. Russell: I would like to add just one thing on this question of the effect of oil on rubber belts. Small quantities of oil about a tenth of a gallon or so, apparently had no appreciable effect on rubber belts, but in plants where 1 to 3 per cent of oil is used for increasing the gas yields, there has been some difficulty and in such cases neoprene belts are used.

Member: In 1949, when we completed our new oven pit, we had difficulty in meeting the production requirements. We had been using oil pressure to that time, and we had been using bumper seed oil. Now, with a little experimentation on gulf spray oil, etc., we were able to settle on a No. 2 fuel oil which we are using at the present time. We were able to reduce our oven schedule, eighteen ovens a day, which was equiv-

alent to about one hundred thirty tons of coke and we are very much in favor of it.

Member: What is the source of the Pocahontas coal and what per cent is used in the mix?

J. K. Kurtz: Our normal mix is two-thirds high volatile and one-third low volatile coal. Part of the low volatile coal comes from Central Pennsylvania area around Johnstown and part from the Southern West Virginia low volatile field.

Operating on a border line mix from an expansion standpoint, and under the necessity of producing every ton of coke possible, bulk density control is an absolute necessity in our plant. Otherwise, if we swing a little out of line, we do not know whether the coke will push or not, as Mr. Kennedy has said.

Member: What is the per cent of Pocahontas used, and what is the moisture content of your coal?

J. K. Kurtz: Our coal as charged is one-third low volatile, of which approximately one-half is Pocahontas. Coming from many different mines, some of which wash the coal and some of which do not, we get wide swings in moisture content of the coal as received. The coal, as loaded to us, has a moisture content of from 3 to 7 per cent, which may be materially increased if it passes through several days of rain en route. Barring heavy rains while in transit, the moisture averages about four per cent.

N. Isenberg: Is your coal mixed before it is crushed?

J. K. Kurtz: Our coal is blended crudely by volume when taken from storage, and we depend on our crushers for intimate mixing. The installation of new equipment, however, is almost completed. This will permit accurate blending by weight just ahead of the crushers and our bulk density control system.

AN APPRAISAL OF MINABLE COKING-COAL RESERVES IN THE UNITED STATES*

▲ THE heavy demands for steel during and since World War II have required large production of coal for the manufacture of metallurgical coke. The largest demand for metallurgical coke is in the Appalachian Region, which comprises central and western Pennsylvania, Maryland, West Virginia, Virginia, eastern Kentucky, Tennessee, and Alabama. This demand is satisfied by coke made from coals mined within the region, and, consequently, the reserves of coking coal in the Appalachian Region are being depleted more rapidly than reserves in other coal-producing areas.

Economic and technologic factors determine whether a particular coal can be used for the manufacture of metallurgical coke. As a result of discussions, the investigations by the Bureau of Mines were planned in three parts:

1. To investigate known (measured and indicated) recoverable reserves of all coking coal.
2. To up-grade marginal coal through effective preparation.
3. To study the carbonizing properties of coals and coal blends not now widely used for making metallurgical coke.

This paper describes methods used in estimating known recoverable reserves and some results of part one of the investigation.

A brief description of some of the detail that must be applied to each coal bed is given. Reserves of each coal bed are reported by counties.

A base map for each bed in each quadrangle was made to the scale 1 in. = 1200 ft. Maps of mines, locations of drill holes, bed and total coal thicknesses, and the outcrop of the bed were plotted on the maps. With all available data plotted, isopach lines were drawn to limit areas of known unmined reserves up to 14 in. thick, 14 to 28 in. thick, 28 to 42 in. thick, and over 42 in. thick. These areas of coal reserves also were divided into "measured" and "indicated" categories. Estimates of total reserves and maps for individual beds were prepared from these data. Recoverable reserves were estimated only for individual beds 28 in. and more thick, based upon recovery in past and present mining.

As of December 31, 1950, the reports on recoverable reserves in Cambria, Indiana, Westmoreland, and Armstrong Counties, Pennsylvania, and Pike County, Kentucky, have been completed. The reports on Cambria and Indiana Counties have been published. The investigation is being continued in Pennsylvania, West Virginia, and eastern Kentucky. Because of the importance of low-volatile and medium-volatile coals, work is being concentrated in counties where these coals are very important.

A comparison of the results of this study, as far as completed, with earlier reports of reserves is of interest and is shown in Table I.

TABLE I

COMPARISON OF ESTIMATE OF RECOVERABLE RESERVES IN PENNSYLVANIA

County	Year made	Minimum bed thickness of recoverable reserves, In.	Recoverable reserves as of date of estimate, millions of tons	Based on a percentage recovery of	Production from year of estimate to date of bureau est'mate, millions of tons	Millions of tons		
						Mining losses from year of estimate to date of bureau estimate	Production and mining losses to date of bureau estimate	Remaining recoverable reserves date of bureau estimate
Cambria	1922	18	3638	74.00	408	144	551	3087
	1942	24	1700	50.00	108	108	216	1484
	1948	28	931	48.77	...	...	...	931
Indiana	1922	18	4289	71.00	204	63	267	4002
	1942	24	2340	50.00	49	49	98	2242
	1948	28	974	48.95	...	...	...	974
Armstrong	1922	18	2491	66.37	111	51	162	2329
	1942	24	1275	50.00	35	35	70	1205
	1949	28	574	46.24	...	...	...	574
Westmoreland	1922	18	3298	63.86	360	205	565	2733
	1942	24	2340	64.00	72	41	113	2327
	1950	28	530	59.00	...	...	...	530

*Abstracted from paper of same title presented by Albert L. Toenges, Principal Coal Mining Engineer, Bureau of Mines, Pittsburgh, Pa., at Blast Furnace, Coke Oven, and Raw Materials Committee of AIMME meeting, Cleveland, Ohio, April 3, 1951.

OPERATION AND MAINTENANCE OF

Electronically Operated Instrument Equipment

By JOHN R. GREEN
Manager Steel Division
Minneapolis-Honeywell Regulator Co.
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. . . . after a decade of industrial usage, the operating characteristics of electronic potentiometers can be evaluated on performance and principles of maintenance . . . .

▲ WITH the continually increasing usage of electronically operated equipment in steel processing and producing plants, a review of one part of this field — namely, potentiometric measurements of temperatures is of interest and value at this time. The performance characteristics of such instruments, as determined from steel plant applications, will be based upon the experience of one company, with which the speaker is associated, and covers performance records extending over a ten year period and including more than 50,000 instruments of the same basic design, as installed in all industries.

As a background for consideration of specific performance advantages, a brief comparison can be made between the operating principles of electronic potentiometers and their predecessors, the mechanical designs.

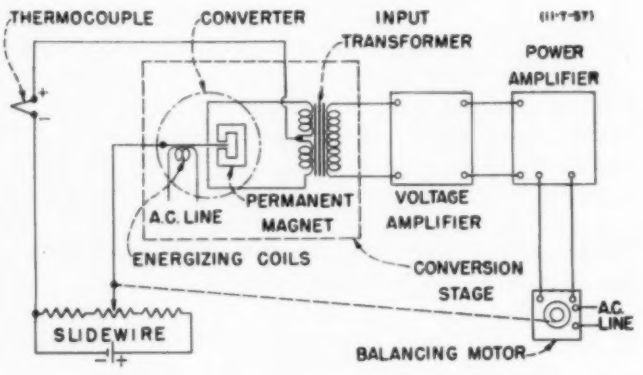


Figure 1 — Schematic diagram for electronic potentiometer circuit.

POTENTIOMETERS

A potentiometer is known as a "null balance" type instrument as opposed to a millivoltmeter which is a "deflectional" type. For purposes of comparison, a millivoltmeter can be likened to the familiar penny weighing scale, where the weight of the person on the platform is opposed by an internal spring mechanism; a potentiometer, on the other hand, functions in the manner of a precision balance in which the unknown weight is placed in one pan, and known weights are added to the other pan until the indicating pointer rests on zero.

There are two types of potentiometers in general use today; mechanically balanced and the electronically balanced instruments. The basic principle employed is the same in both types, that is, balancing the unknown voltage developed by the primary measuring element against the known voltage from a battery within the instrument. A change in temperature at the measuring element causes a condition of unbalance in the electrical bridge circuit. The amount and direction of unbalance is measured, and the slidewire is repositioned to effect balance. Repositioning of the slidewire moves the pointer or pen to indicate or record the temperature.

MECHANICALLY BALANCED POTENTIOMETER

In the mechanically balanced instrument, the direction and amount of unbalance are indicated by a galvanometer. A detecting mechanism determines the position of the galvanometer pointer and, through a mechanical linkage, repositions the contactor on the slidewire until re-balance is obtained. The detecting and balancing actions are periodic, resulting in an

inherent lag. The large number of moving parts employed results in appreciable wear and increased maintenance. Where the instrument is located a distance from the primary measuring element, the external resistance of the long extension wire may result in a decrease in sensitivity.

ELECTRONICALLY BALANCED POTENTIOMETERS

Most modern instrument in the field of temperature measurement, the electronic potentiometer combines the advantages of the mechanical potentiometer with additional advantages of its own. Like the mechanical instrument, the electronic potentiometer utilizes the potentiometer bridge measuring circuit.

In the latter instrument, however, a compact electronic unit performs *continuously* the same task that the multiplicity of moving parts in the mechanically balanced potentiometer perform *periodically*. The galvanometer and mechanical detecting mechanism of the mechanically balanced type are replaced by a small unit which amplifies the unbalanced voltage electronically and uses the amplified unbalance to control the speed and direction of rotation of a balancing motor which in turn drives the pen and pointer. With the electronic instrument, temperature measurement is continuous rather than periodic, i.e., a change in temperature sensed by the primary measuring element causes immediate repositioning of the pen and pointer. The speed of response of such an instrument is limited only by the speed of response of the primary measuring element.

Neither the sensitivity nor the accuracy of this instrument is affected by external circuit resistance, a factor which makes it possible to locate the indicator or recorder any practical distance from the point of measurement. It is ideally suited for multiple indicating and recording. The electronic unit, like the mechanical potentiometer, is suitable for use with a variety of primary elements. This, of course, simplifies maintenance and reduces the stock of spare parts normally carried.

A schematic diagram of the electronic potentiometer circuit is shown in Figure 1 which illustrates the detection of d-c unbalance through a converter unit, producing an a-c component which is then stepped up through a transformer and successive stages of electronic voltage and power amplification to drive a rebalancing motor. The potentiometer slide wire, as well as the indicating pointer, recording and control mechanisms, are directly connected to this two directional motor.

CHARACTERISTICS ADVANTAGEOUS IN STEEL MILL OPERATION

Continuous balance — The continuity of measurement, which is inherent in electronic systems, in contrast to the periodic or cyclic rebalancing of mechanical instruments is shown in Figure 2.

The effect of such continuity of measurement on the quality of control continues as a surprise even after years of experience. Simpler methods and forms of control can be used to hold furnace conditions within allowable product limits, therefore not only simplifying maintenance, but lowering initial investment costs.

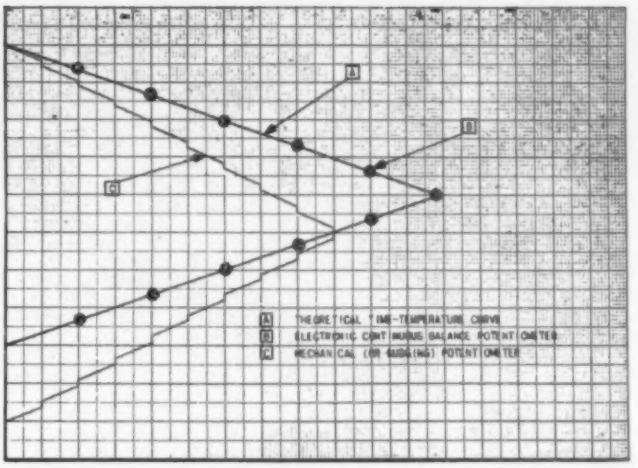
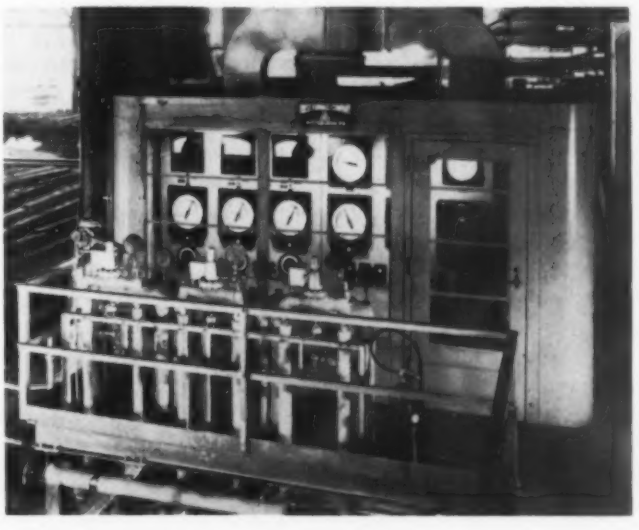

A THEORETICAL TIME-TEMPERATURE CURVE
B ELECTRONIC CONTINUOUS BALANCE POTENTIOMETER
C MECHANICAL (OR KICKING) POTENTIOMETER

Figure 2 — Electronic equipment enables continuous measurement of values.

Figure 3 — Bath temperature measurements are made with this thermocouple.

Figure 4 — A modern billet heater control panel shows tendency to protect instruments.



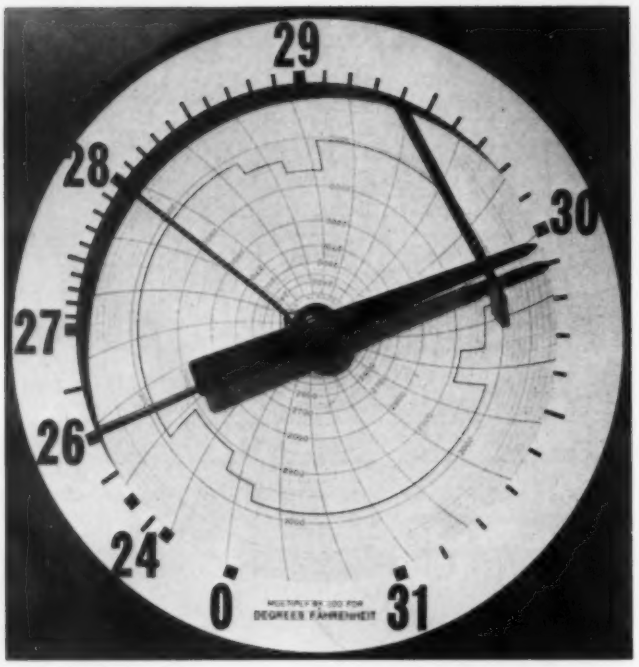


Figure 5 — Measuring circuit is designed for full scale span of only two millivolts.

This characteristic also makes it practical to accomplish many of the things which have been done in the field of bath temperature measurement. Figure 3 illustrates one form of such equipment which makes use of platinum thermocouples for the measurement of steel temperatures prior to tapping in open hearths or electric furnaces.

Few moving parts — A second characteristic is a material reduction in the number of moving parts required in the instrument design. This greatly reduces the effect of corrosion, abrasion and acid fumes which are present in so many of the steel mill locations. Even the few moving parts are stationary whenever the temperatures remain constant.

The instrumentation involved in blast furnaces and blast furnace stoves, is a typical example of extremely abrasive conditions which are encountered.

The acid fume conditions which exist around pickling operations, is another example where a few moving parts and the ability to air purge the cases greatly increases instrument operating life.

Unaffected by vibration — A third characteristic is freedom from the effects of vibration. For greatest utility, many of the instruments used in the steel industry have to be located where vibration and shock conditions are quite severe. An electronically operated instrument is unaffected by these conditions and eliminates the necessity for elaborate shock dampening or spring mounting.

A typical example are the controls for slab reheating furnaces located almost directly above the tables and subjected to extreme shock.

A modern billet heater control panel is illustrated in Figure 4, which is a typical example of the present trend to protect and enclose instruments in control rooms for greater utility.

Higher accuracy — Although increased accuracy and sensitivity of measurement are inherently secured in electronic potentiometers, this is not considered to be of prime importance as far as the majority of steel mill applications are concerned. Certain applications such as control of hot dip tinning and the control of some electrolytic and cleaning solutions can take practical advantage of this greater accuracy.

Faster operation — Another obvious advantage in electronic instruments is the ability to secure, where necessary, higher recording speeds. Instruments are now available with full scale pen travel of 2 seconds or less. The measurement of product temperatures during high speed rolling or forming operations by means of radiation or self-balancing optical systems are typical examples where this high speed can be used to advantage. However, it is well to point out that the use of instruments with higher speeds than the ability of the sensing or measuring elements to detect the temperature changes is simply increasing instrument wear and maintenance unnecessarily.

Narrow spans — The ability of electronic instruments to provide narrower instrument spans has served many useful purposes in the steel industry.

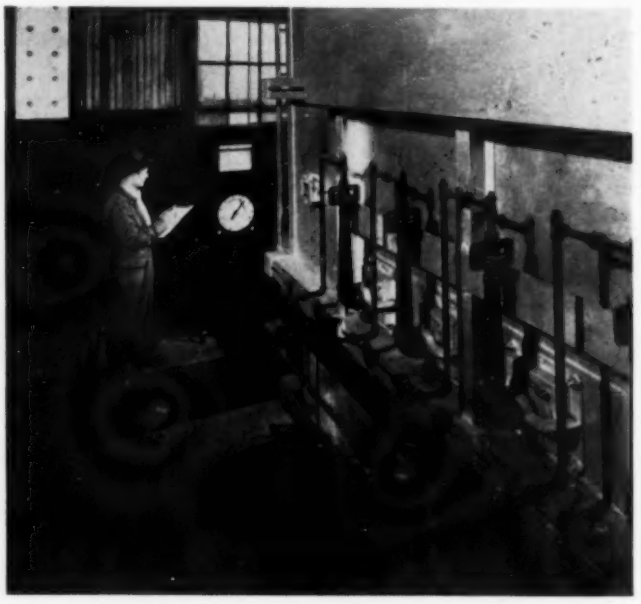


Figure 6 — All steel as well as cover temperatures are recorded on this instrument which controls an annealing unit.

Low temperature measurements, which previously used bulb and capillary tubing type of thermometers, in such installations as pickling and other cleaning baths are handled with lower maintenance, less down time and greater accuracy by electronic potentiometers.

The purged sighting tube method of bath temperature measurement makes use of a photo cell located in the outer end of the tube as the temperature sensitive element. The greatest stability under all operating conditions is secured by designing the measuring circuit for the recorder, illustrated in Figure 5, for a full scale span of only two millivolts. Such a narrow span is possible only with electronic principles of operation.

Parallel operation — The measuring circuit characteristics capable of being handled by electronic instruments also permits parallel operation of multiple recorders with single point instruments, from the same thermo-

couples or radiation elements, and without "bumping" the continuous indication when the same measurement is switched into or out of the multiple recorder circuit.

This characteristic is used to advantage in the open hearth reversal panel where an indicating differential instrument is used to signal or initiate reversal from temperature difference between incoming and outgoing checker chambers or flues, while the actual temperatures are being recorded from the same temperature sensing elements on a multiple electronic recorder.

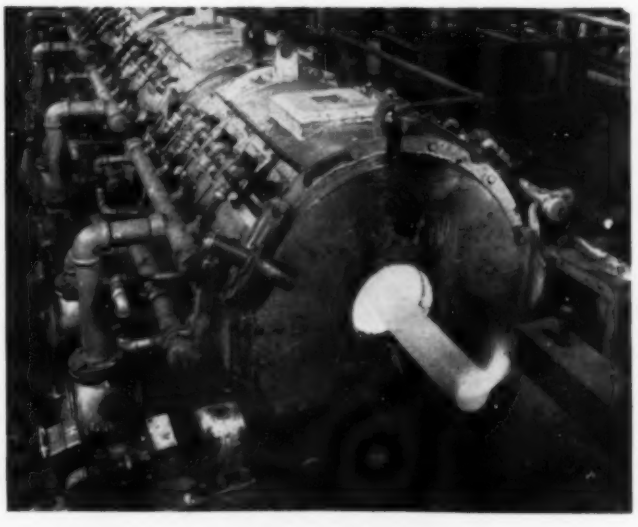
The same principle is used to advantage in control systems for portable annealing covers. A unit assembly for this service includes a multiple electronic instrument recording all temperatures throughout the steel charge as well as the cover furnace temperatures for direct comparison. Individual indicating or recording control instruments, operated in parallel from the same thermocouples, provide continuous control of the steel and cover temperatures, with resultant better quality of control, greatly simplified design of the individual instruments employed, as well as the elimination of switching and recycling relays.

Figure 6 is an illustration of one unit from a large installation which has simplified the installation and improved the quality of tin plate annealing. A single pneumatic control instrument is operated in parallel with a multiple electronic, recording all of the steel as well as the cover temperatures.

Lock-in position — The ability to lock an electronic instrument in its last position by de-energizing the balancing motor circuit has been used to advantage in a number of steel mill applications. In the photoelectric bath pyrometer, as previously illustrated, the rebalancing circuit is energized only at the time of taking the reading. This provides a permanent indication of the last temperature measurement as well as a record of the time at which that measurement was made.

This same feature is used to advantage in the control of multi-furnace high speed radiant heating units illustrated in Figure 7. The temperature measurements, and therefore the control of fuel volumes based upon product temperature at the entrance to each furnace zone, are automatically locked in position between each seamless tube being heated. Figure 8 shows the interlock between product temperature control, a high limit on furnace temperature and light sensitive cells to detect the presence of work.

Figure 7 — Fuel volumes are automatically blocked in position between each seamless tube which is heated.



The individual characteristics of electronic instruments as outlined above are, in many cases, combined to secure the best solution for many steel mill measuring problems.

The measurement and recording of emergent coke temperatures is a typical example. The radiation temperature measurement element, which is air purged and sighted on the coke as it is pushed from the bench, is connected to the recording unit which is mounted in the cab of the door machine car. A complete cabinet design for this service includes the electronic strip chart recorder as well as the electrical units for supplying a-c from the 230-volt d-c available, the air cleaning filters and the purging system blower. The instrument used for this service must combine the features of continuous measurement and high pen speed, as well as the ability to withstand extreme conditions of heat, dirt and vibration.

Equipment for the measurement and checking of flame radiating power and its distribution through an open hearth furnace makes use of electronic recording equipment to provide continuity of measurement, relatively high speed recording, and ability to operate under severe vibration and transporting conditions.

In open hearth roof temperature measurement, the electronic form of instrument, because of its continuity of measurement and response to small changes as well as freedom from vibration, has increased the practicality of automatic roof temperature control. The throttling action required on the fuel valve to hold roof temperatures within safe limits is secured by such a measuring and control system without radical changes in fuel supply which can seriously upset furnace working conditions.

Many of the characteristics of electronic potentiometers are utilized to advantage in combination with a variety of analytical or laboratory devices. Figure 9 illustrates pH measuring equipment used in combination with an electronically operated instrument to control the treatment of waste pickle liquor. Metallurgical and research laboratories make use of various designs of spectrographic analysis equipment which incorporate high speed electronic recorders of special design and modified measuring circuits.

The use of the strain gage principle in combination with electronic indicating or recording instruments is finding many applications throughout the steel industry. Resistance strain gage units or tension links, which may be mounted on conveyors, platforms, or cranes are being used to continuously record the weight of ingots, furnace charging, steel pouring and steel storage or shipments in warehouse operations. Automatic range changing mechanisms built into the electronic instruments have provided a readability to one part in 5000 for such weighing applications.

Although electronic instruments have been the central theme of these applications, it should be noted that electric control systems of modern design employ relays which make use of similar electronic principles. Figure 10 illustrates a continuous heat treating furnace in a steel plant which is controlled by electronic instruments

and relays to operate electric proportioning valve motors in the fuel lines to each zone.

MAINTENANCE AND SERVICE OF ELECTRONIC INSTRUMENTS

The subject of instrument maintenance and service as applied to electronic instrument designs is worthy of some specific comments. Although electronic principles are being used in a great variety of industrial equipment by modern steel plants, the feeling still exists in some instrument departments that their organization must be trained as electronic experts. As far as electronically operated potentiometers and their associated equipment is concerned, such extensive training is not required. Some definite comments on this point should be of value, both to management and those who are directly responsible for maintenance and the training of personnel.

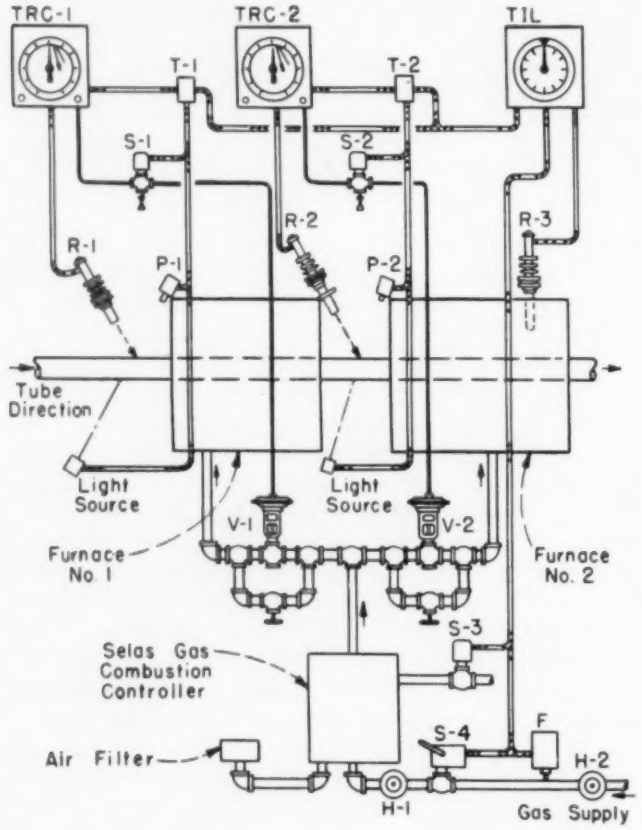
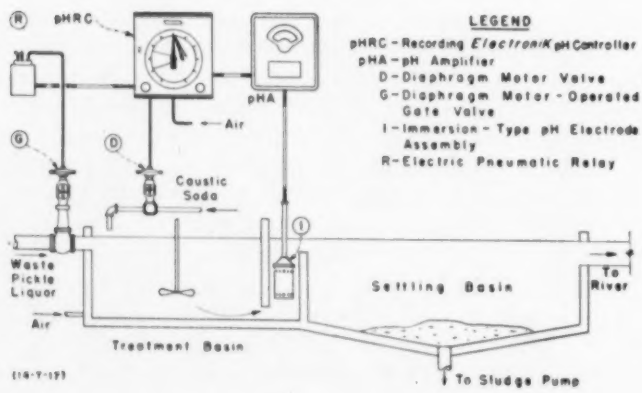


Figure 8 — Schematic diagram shows interlock between product temperature control, furnace temperature and photocells.

Figure 9 — The pH values are automatically controlled in the waste pickle liquor treatment.



The carefully kept records of one plant covering several hundred potentiometers of both mechanical and electronic designs, and extending over a period of approximately four years, disclosed that the labor and material maintenance cost for instruments operating on electronic principles is less than one-third of that required for all makes of mechanically operated units. The inventories of service parts were reduced to 20 per cent of the previous requirements and there were fewer emergency service calls. At the same time, maintenance personnel required less training for work on electronic instruments.

The complete assembly of electronic components, with which the service engineer is concerned, is shown in Figure 11 illustrating a continuous balance unit. This easily replaceable unit with its standard vacuum tubes, takes the place of the galvanometer, a galvanometer position detecting mechanism, and the rebalancing mechanism of any mechanical potentiometer.

The dependability of this continuous balance unit and the lack of any requirement for major field servicing is illustrated by the fact that from over 50,000 of these units installed over a period of ten years on industrial service, less than 3 per cent have ever required major repairs or replacement. The converter unit has a record of a fraction of 1 per cent replacement over the same total service period.

What this means in actual plant maintenance procedures is that one complete unit can be carried in stock as a spare replacement for 50 to 100 operating instruments.

The electronic tubes which are used in the circuit are all standard and procurable from any radio supply store. For most efficient service, the two voltage amplifying tubes are normally tested by the instrument manufacturer to more rigid standards than required for radio service. It is, therefore, recommended that spare tubes for this service be obtained from the instrument manufacturer, even though the cost may be a few cents higher.

In the event of voltage amplifier tube failure, one of the power tubes may be used as an emergency replacement until a new tube of the proper type is obtained. The power amplifying tubes are operated in parallel, and the instrument will function with only one tube. It should be pointed out that the instrument measuring accuracy is not in any way a function of tube characteristics or performance.

The life of vacuum tubes is not definitely predictable, but is continually being improved by the manufacturers and is enormously increased by being continuously energized rather than subjected to the intermittent heating as found in radio service. If a tube does not fail in the first few hours of usage, it will probably have a very long life. Although tests in instrument service have indicated average tube life of two to three years, it is recommended that periodic tube replacement be made at intervals of six months to a year.

Resistance and voltage checks between all terminals of the continuous balance unit can be made against

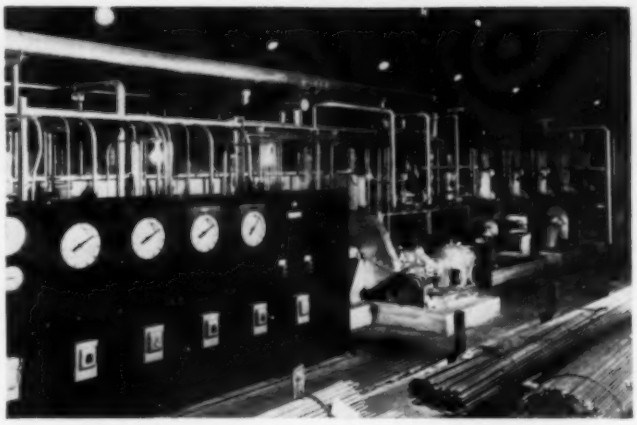


Figure 10 — The electric proportioning valve motors on this continuous heat treating furnace are controlled by electronic instruments.

Figure 11 — Units are easily replaced thus simplifying maintenance procedure.

published values, however, the infrequency of this requirement makes it more practical for the average plant to install a complete new unit at a nominal replacement cost.

A problem which does exist for the instrument service engineer is to rapidly determine on the job the cause of any instrument failure. As a solution to this problem for electronic potentiometers, a piece of equipment is available which checks tubes, converter, transformer, rebalancing motor and all electronic components. It is light in weight, has a built-in power supply with reversing switch, and can be dropped on the floor or even stepped on. All that it consists of is a differential thermocouple. When clamped onto the input terminals of the electronic unit, by holding one terminal between the fingers, the pen or pointer of the instrument will continue to move in one direction — while holding the other junction will reverse the direction of movement. Whenever this action takes place, all of the electronic components are in perfect working order, and the usual checking procedures for thermocouple, lead wire, slide wire, battery and standard cell can be followed, as required on any potentiometer pyrometer.

This simple and rapid method of checking the complete electronic circuit at the instrument location has done much to remove the feeling that any advanced knowledge of electronics was necessary by the service engineer.

These examples of both maintenance procedures and some of the many applications have been presented to rapidly illustrate how and where instruments operating on electronic principles can do a better job in a simpler manner or provide for the first time a means of securing measurements which are desirable for more efficient steel plant operation.

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FUSES AND CIRCUIT BREAKERS FOR SHORT CIRCUIT PROTECTION

By K. S. KUKA
Supt. Electrical Engineering and Construction
Tata Iron and Steel Co., Ltd.
Jamshedpur, India

. . . . tests show that fuses which have 3½ times current rating of overload relay or 4 times current rating of motor should permit maximum safe loading of the equipment . . . .

▲ In a steel plant, an electrical engineer must handle electrical apparatus, such as electro-magnetic contactors, starters and switches which operate often about a thousand times an hour under rather severe conditions. Such starters and circuit breakers frequently blow off while trying to operate on short circuits, due to electrical faults which cannot always be avoided. Starters and switches are frequently mounted near workmen and it is essential that adequate short circuit protection is provided for all equipment connected to various branch circuits.

Safety rules should therefore be strictly observed, because the available short circuit energy in the steel plant electrical system network is high due to a heavy concentration of power in a comparatively small area.

The phenomena of electrical circuit interruption have been so effectively studied that it is now possible to design circuit breakers which can safely and smoothly handle several million kva "short-circuit energy," and the art of manufacture of circuit-breakers and fuses has now advanced so far that it is always possible to provide the correct type of circuit interrupting devices for all possible situations and conditions.

In an industrial plant, however, especially on a medium voltage network, economical considerations do not always permit costly apparatus and it therefore becomes necessary to find compromises, with the result that wrong apparatus is often applied, which creates hazardous conditions. In addition, electrical maintenance personnel are sometimes not well enough acquainted with basic principles of circuit interruption, with the result that they do not foresee possible hazards for a particular installation under short circuit conditions.

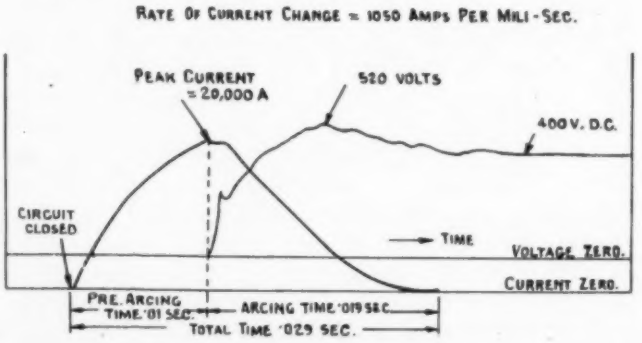
It is the object of this paper to explain in general terms the phenomenon of arc interruption in an electrical circuit and explain the behavior of small circuit breakers and fuses under short circuit conditions, so that it is possible to understand and appreciate the best protection that can be effected economically.

PHYSICAL PHENOMENA OF CIRCUIT INTERRUPTION

As long as a current is carried by metallic conductors and the emf is maintained, it can only be interrupted by interposing in its path, a gap constituted by two contacts drawn apart, i.e. a switch, or by destroying part of the metallic path, i.e. a fuse. In both cases, when introducing the gap, an arc is formed between the conductors on either side of it. The problem of circuit interruption thus becomes one of arc extinction. All switches and circuit breakers, upon whatever principle they are designed, are devices for drawing an arc and then extinguishing it.

The process of circuit interruption essentially lies in increasing the resistance of the space between the contacts from a value of the order of a fraction of an ohm

Figure 1 — This short circuit test of a 500-amp cartridge fuse with an open circuit voltage of 400 volts shows that the arcing time is about double the time required to melt the fuse. The maximum value of the test current was not less than 35,000 amps.



to one of a very great magnitude. It is therefore important to understand the phenomena which occur in the arc during its extinction.

An arc is formed by the passage of a current through a gaseous medium which, in case of an oil or water circuit breaker, is produced by the arc itself through vaporization of the liquid material surrounding it.

Due to current flow, the gas surrounding the contacts is ionized and the atoms are split up into negatively charged electrons and positively charged protons. This results in the generation of a certain number of negatively charged particles consisting of the liberated electrons, along with a corresponding number of positive particles consisting of the nuclei of the atoms.

Although the positive particle is several thousand times heavier than the electrons, the electrostatic force acting upon it is usually about the same as that acting upon an electron, as the charge on the positive particle is either equal or at most a small multiple of it. The result is that the positive particles together with the undissociated atoms play the part of a more or less stable medium in which electrons moving under the influence of the potential gradient of the electric field carry current. The conductivity depends upon the number of free electrons present per unit volume and upon their mobility. It is found that the conductivity of an arc column such as is formed between the contacts of a circuit breaker may be expressed, as given by Dr. Kesselring:

$$Ca = \frac{neb}{l} \times \frac{\pi d^2}{4}$$

where n = number of free electrons per cm³

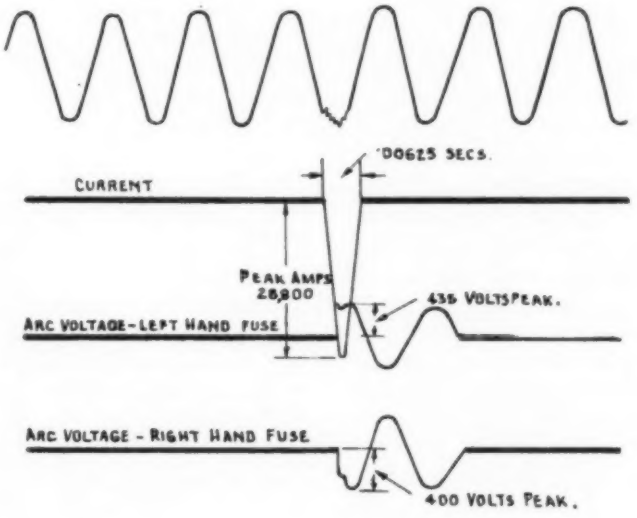


Figure 2 — Oscillogram on tests of 400-amp fuses.

b = factor expressing the average mobility of the electrons in centimeters per second per volt per centimeter.

d = diameter of the arc column.

e = charge on the electrons, i.e. 1.59×10^{-19} coulomb.

l = length in cm of the arc column.

The value of (Ca) may be altered by varying any one of the factors n, b, l or d. The charge of the electron being a fundamental constant does not alter. The temperature and pressure in the arc column itself only vary to a limited extent, so that the variation of b which depends upon these factors is also small. There are therefore three possible ways of reducing Ca, namely:

1. Increase l;
2. Reduce d;
3. Reduce n.

In the arc, ionization is chiefly formed by collision of the atoms with another due to the agitation produced by high temperature and that produced by bombardment of the atoms by the electrons which are accelerated to a high speed by the potential gradient of an electric field.

On the other hand, the charged particles may disappear from the arc column of a circuit breaker in two ways:

1. By recombination of positive and negative particles in the arc column itself. This occurs under certain conditions when positive and negative particles collide.
2. By diffusion of the mobile particles out of the region. The electrons either stick to the neutral gas molecule and lose their mobility, or reassociate with the positive particles with which they come into contact.

There is thus a race going on between the ionization

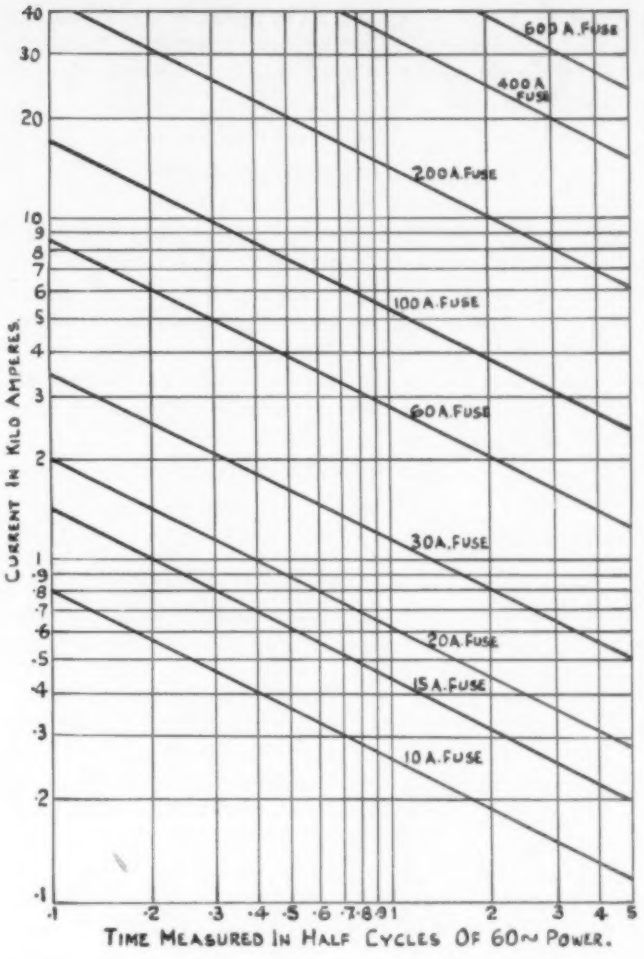


Figure 3 — Chart shows time required for low voltage zinc fuse link to melt.

process due to the electric field present as well as the high temperature and the natural process of deionization. If the deionization process predominates, the arc is extinguished.

EXTINCTION OF D-C ARCS

In order to extinguish the d-c arc, the only means are to decrease the thermal ionization, i.e. to cool the arc, and to reduce ionization by bombardment, i.e. to reduce effects of the potential gradient. This is practically done by blowing the arc and lengthening it into specially provided arc chambers at the same time separating the contacts to a sufficiently long distance. The arc is thus broken and quenched.

Work done by the switch in interrupting the circuit is expressed as:

$$A = \int_0^{\tau} i e_s dt \qquad (1)$$

Where i is the breaking current and e_s is the voltage between the contacts and τ is the operating time of the breaker in seconds.

$$e_s = E - Ri - L\frac{di}{dt} \qquad (2)$$

where E = line voltage.
R = circuit resistance.
L = circuit reactance.
Therefore:

$$A = \int_0^{\tau} \left(E - Ri - L\frac{di}{dt}\right) idt \qquad (3)$$

$$= \int_0^{\tau} (E - Ri)\, idt - \int_I Lidi \qquad (4)$$

$$= \frac{LI^2}{2} + R\int_0^{\tau} (I - i)\, idt \qquad (5)$$

where I is the initial breaking current and E = RI.

The solution of the above equation as given by Dr. Rudenberg is:

$$A_{(max)} = \frac{LI^2}{2} + \frac{RI^2}{6} \qquad (6)$$

If we take L/R = T = Time constant of the circuit, maximum work done by the switch will be given as:

$$A_{(max)} = \frac{1}{2} LI^2 \left(1 + \frac{1}{3}\frac{\tau}{T}\right) \qquad (7)$$

In equation (5), the first part represents the inductive energy stored in the circuit which appears wholly at the switch contacts, while the second part of the equation represents the energy fed into the switch from the source, where the short circuit current goes on reducing up to zero when the circuit is broken.

For a highly inductive circuit, where R is small compared to L, the work done by the switch will be $\frac{LI^2}{2}$, which can be taken as the minimum work done by the switch.

It should be appreciated that for highly inductive circuits, though the magnitude of power handled by the switch is minimum, the effect on the switch arcing contacts is maximum, because the whole energy as represented by $\frac{LI^2}{2}$, is handled at the moment of the opening of contacts and does not vary with the operating period of the switch.

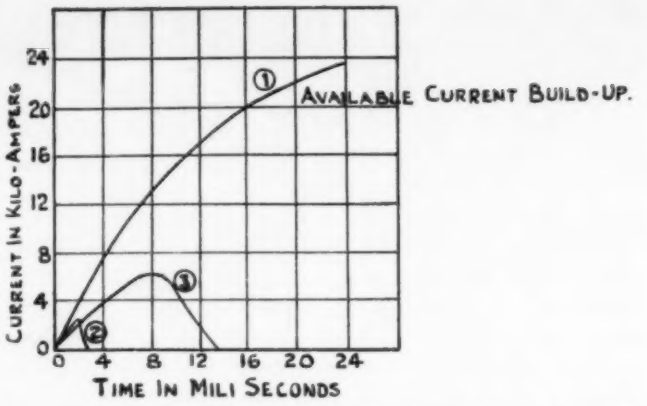


Figure 4 — Curve shows current buildup following short circuit on 250-v, d-c supply. Curve 2 is for 30-amp fuse, and curve 3 is for 25-amp circuit breakers.

EXTINCTION OF A-C ARCS

In case of alternating currents, the current passes through zero at every half cycle. It is therefore natural that at the current zero point, the ionization process is minimum whereas the de-ionization continues to proceed. Thus, an a-c arc has the natural tendency to quench itself at current zero. However, because of heat which still remains in the arc path and because of the voltage which rises between the contacts, the arc tends to restrike. If therefore the deionization process is increased such that the arc is not able to restrike after current zero, the circuit can be easily interrupted even after the first current zero.

In case of low-voltage a-c circuit breakers, as soon as the contacts separate and an arc is drawn between them, a blow-out coil comes into operation and blows the arc into the arcing chamber. The arc is thus lengthened and consequently cooled. The restriking voltage is then not able to restrike the arc once it is quenched.

The work done by the switch can be expressed by the following equation given by Dr. R. Rudenberg:

$$A = \frac{\tau}{\pi} \times \frac{eb}{ez} \times EI$$

The above equation means that the work done by the circuit breaker is determined by the current amplitude (I) just before interruption, and the voltage (E) just after interruption, the time of operation of the switch (τ), as well as on the ratio of the arc voltage (e_b) to the restriking voltage (e_z).

For practical purposes however, the rupturing or the interrupting capacity of a circuit breaker is defined as follows:

1. For 3 phase circuits:
   Short-circuiting interrupting capacity in kva = $\sqrt{3}EI$.
   where I = breaking current in kilo-amp.

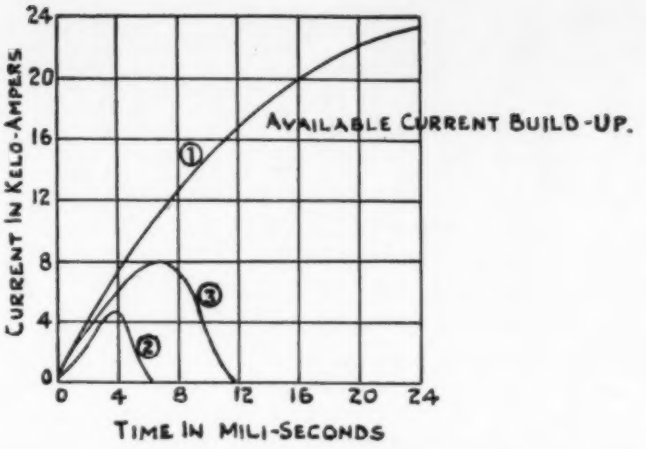


Figure 5 — Current buildup is shown following short circuit on 250-v, d-c supply. Curve 2 shows I^2t value equals 62,000 when through two 250-v, 60-amp fuses, and curve 3 shows I^2t value equals 352,000 when through a 50-amp, double pole, circuit breaker.

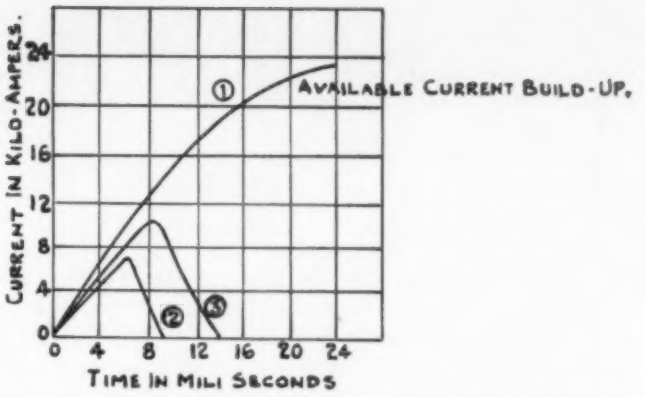


Figure 6 — Curves show current buildup on short circuit on 250-v, d-c supply. Curve 2 shows I^2t value equals 170,000 when through two 250-v, 100-amp fuses, and curve 3 shows I^2t value equals 582,000 when through a 100-amp, double pole, circuit breaker.

E = recovery voltage (taken as the line voltage in volts).

2. For single phase circuits or d-c circuits:
Rupturing capacity = (breaking current) × (line voltage).

Every circuit breaker or the fuse should therefore be able to handle the energy generated during short circuits, i.e. it must have sufficient thermal capacity in its contacts to withstand the heat and sufficient mechanical strength to withstand the shock. It must also be able to quench the arc within a fixed time without causing flash-overs and transient voltage surges.

OPERATION OF A FUSE UNDER SHORT CIRCUIT

A one-time fuse is a specially designed device which can handle high short circuit energy generated during its operation. A fuse wire of special material, either silver or zinc, is enclosed in a sealed cartridge. The cartridge is filled with chemically treated quartz which serves as a quenching medium. It is this quenching medium that gives the high interrupting capacity to the fuse cartridge.

In Figure 1 is reproduced an oscillogram showing the operation of a fuse on a 400 volts d-c circuit. It is observed that the current rises up to a certain peak value until the fuse melts. When the arc is formed after melting of the fuse element, a resistance is automatically introduced into the circuit which reduces the current until the arc is quenched. The fuse thus acts as a current limiting device which interrupts the circuit before the circuit can attain its maximum peak depending on the short circuit power available in the system.

In Figure 2 is reproduced an oscillogram of a 400 amp fuse operating on a short circuit on 500 volts a-c. It is observed that a peak current of 28,800 amp is cleared within 0.00625 second.

Study of the oscillograms in Figures 1 and 2 shows that there are two factors to be observed in considering the interrupting speed of fuses viz., time in which the circuit is interrupted and the available energy which can be interrupted. For the time of interruption, there are two important factors namely, the time required to melt the fuse and the time required to interrupt the circuit. The oscillogram of Figure 1 shows that for a total fusing time of 0.029 second, 0.01 second is the melting time and 0.019 second is the arcing time; thus the arcing time is about twice the melting time for the fuse. Oscillogram in Figure 2 also shows almost the same relationship. Tests on fuses have shown that for very high values of currents, twice as much additional time is required for circuit interruption as is required to melt the fuse. During the arcing period, the current decreases quickly from its peak value when the fuse melts. The peak voltage on the system created by the operation of the fuse is also clearly observed from the oscillograms in Figures 1 and 2. It should be observed that a fuse is prone to create a voltage surge on the system if not properly designed.

INTERRUPTING ABILITY OF FUSES AND CIRCUIT BREAKERS

Figure 3 is reproduced to show the fusing characteristics of some one-time fuses. It is seen that a 60-amp fuse interrupts 7500 amp in about 0.00125 sec. This means that the fuse prevents the current from materially exceeding the value reached at melting. It means that the fuse is a sort of current limiting device which interrupts the circuit so fast that the short circuit current is not able to reach its maximum peak. For a fuse to be current limiting therefore it must melt in the early stages of a half-cycle, preferably at one-fourth of the half cycle. From Figure 3 it can be seen that the current limiting effect becomes more pronounced on the smaller size of fuses. Fuses of higher than 200 amp rating do not give appreciable current limiting effects.

In Figures 4, 5 and 6, current-time curves are reproduced showing the interrupting characteristics of high interrupting capacity fuses as compared to circuit breakers. Curve 1 in each figure gives the short circuit current build-up as available from the power source; the curve 2 gives the build-up and cut-off limits of the $I^2 \times t$ (i.e. current squared into time) values as given by the fuses, and the curve 3 gives those for the circuit breakers. In Figure 4, two 30-amp fuses are compared to a double-pole 30-amp circuit breaker; in Figures 5 and 6, two 60-amp and two 100-amp circuit breakers

are similarly compared. The comparison shows that the respective $I^2 \times t$ values which the fuses, as compared to circuit breakers, allowed to pass through, were 5500 versus 288,000; 62,000 versus 352,000; 170,000 versus 582,000 respectively, depending on the size of the interrupting apparatus. The above figures were obtained with a system which could give a maximum short circuit current of about 24,000 amp.

If the apparatus are connected to a system which can give much higher short circuit current as is the case in large steel plants, it can be appreciated that the small size circuit breaker is likely to be distressed in handling the enormous energy that will be generated during a short circuit.

INTERRUPTING RATING OF CIRCUIT BREAKERS AND FUSES

The data shown in Figures 4, 5 and 6 clearly indicate the differences in the operating characteristics between the circuit breakers and the fuses. The main feature of the fuse is the fact that it is much faster in its operation and therefore has a greater current limiting effect than a circuit breaker, partially for smaller sizes. The fuse therefore does a very much superior job in protecting smaller devices against excess energy.

It should not, however, be concluded that every fuse or every circuit breaker can handle every short circuit. The fuse or the circuit breaker must necessarily possess the ability to handle the power involved in clearing a short circuit fault, i.e. it must have the required interrupting capacity. The contacts must be able to stand the heat generated by the heavy current and the mechanical strength must be enough to stand the very heavy electro-mechanical forces generated. It is therefore only the specially designed and tested high rupturing capacity fuses that can handle the heavy short circuits.

CONCLUSIONS

1. Since available energy in a large industrial plant such as a centralized steel plant is high, it is essential that special attention is paid to protection against short circuits.
2. For overload protection of motors, correctly designed overload relays should be used. Thermal overload relays adapted to the motor heating characteristics are the most suitable.
3. For short circuit protection, properly selected high interrupting capacity fuses provide the best solution. A fuse has an intrinsic characteristic of limiting the short circuit current. A small size fuse handles a smaller magnitude of current than a larger size one, though connected in the same circuit. The fuse is thus the best short circuit protection for small size starters.
4. For larger sizes, a circuit breaker can give a fairly good short circuit protection. However, for smaller sizes, a circuit breaker cannot always give full protection because of its rating. As shown in Figures 4, 5 and 6, under certain conditions, the short circuit energy permitted through by a 30-amp, a 60-amp, and a 100-amp fuse respectively will be about 2 per cent, 25 per cent, and 30 per cent of that which would be permitted by similar size circuit breakers to flow through under similar conditions. A high rupturing capacity fuse can therefore give adequate short circuit protection even to a circuit breaker, and thus makes it possible to use a lower capacity breaker even where high short circuit currents are involved.
5. As a rule, for adequate protection, the maximum fuse that should be selected is about 3½ times the current rating of the overload relay, or 4 times the current rating of the motor which should permit maximum safe loading of the equipment.

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Report of Activities

OF AISE STANDARDIZATION COMMITTEE - 1950

By LEO J. GOULD

Chairman AISE Standardization Committee

▲ DESPITE the intense pressure caused by the activities in the steel industry, members of the Association of Iron and Steel Engineers standardization sub-committees made a great deal of progress on their various projects during the year. A number of projects have practically been carried through to completion and several were completed. The following projects are still under way under the sponsorship of the committee chairmen mentioned:

1. **Steel Mill Gearing**
   Sub-committee chairman LEO GOULD, Chief Engineer Construction, Bethlehem Steel Co., Bethlehem, Pa.
2. **Standardization of Size, Length, Breadth and Type of Shunting for Motor Brushes**
   Sub-committee chairman E. L. ANDERSON, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.
3. **Standardization of Low Voltage A-C Control**
   Sub-committee chairman H. H. ANGEL, Electrical Engineer Const., Bethlehem Steel Co., Bethlehem, Pa.
4. **Development of Data for Steel Plant Filters**
   Sub-committee chairman A. H. ARBOGAST, Combustion Engineer, Bethlehem Steel Co., Bethlehem, Pa.
5. **Crane Wiring Standard**
   Sub-committee chairmen J. E. BODOH, General Supervisor Electrical Dept., Carnegie-Illinois Steel Corp., and C. G. DIMITT, Supervisor Design Engr. (Electrical), Carnegie-Illinois Steel Corp., Chicago, Ill.
6. **Steel Mill Lighting**
   Sub-committee chairman J. J. BOOTH, Division Supt. Maint., Carnegie-Illinois Steel Corp., Duquesne, Pa.
7. **Crane Limit Switches**
   Sub-committee chairman R. W. GRAHAM, Electrical Supt., Bethlehem Steel Co., Lackawanna, N. Y.
8. **Rolling Pressures and Power Requirements for Rolling Mills**
   Sub-committee chairman C. L. McGRANAHAN, Technical Assistant to Works Manager, Sollac, Thionville, France.
9. **Flexible Couplings**
   Sub-committee chairman H. W. NEBLETT, Special Engineer, Inland Steel Co., East Chicago, Ind.
10. **Handbook of Lubrication Standards**
    Sub-committee chairman C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.
11. **Mill Motor Brake Standardization**
    Sub-committee chairman V. E. SCHLOSSBERG, Supt. Electric, Power and Steam Dept., Inland Steel Co., East Chicago, Ind.

The following projects were essentially completed during the year:

1. **Mill Motor Standard Revision**
   Sub-committee chairman M. B. ANTRIM, Supt. Elec. Maint., Lukens Steel Co., Coatesville, Pa.
2. **Recommended Plain Bearing Design Practice**
   Sub-committee chairman C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio.
3. **Design of Hot Metal Ladles**
   Sub-committee chairman F. E. KLING, Tenafly, N. J.

Reports on these latter three projects will be given at this meeting as well as on the program of the Carbon Brush Standardization, Wiring Standardization and Low Voltage A-C Control Standardization Committees.

I am going to report briefly on some of the projects which will not be given by the committee chairmen themselves. The first one which I will discuss is my own particular assignment on the standardization of gearing. In taking on this topic, we thought it would be advisable to attempt standardization within our own company first, and if that could be successfully accomplished, it was our feeling that we might be able to go ahead on an industry-wide basis. To date the problem has been largely educational. So far we have standardized on nomenclature for gear dimensions and gear failures using the AGMA standards as a foundation. We have also recommended that where the use of existing spares is not too important, all new gears will be 20 degrees involute full depth, if this does not give interference. We will also have a sub-committee working on the proper dimensions for long and short addendums and standard methods of showing full dimensions on drawings. We are planning to prepare tables which will give necessary dimensions for the various numbers of teeth to be used in our shop manufacture, and this latter will of course involve setting up standard backlash as well as decisions on tolerances for various classes of gears. We expect that it will take another year before we will have anything definite to present before the group.

The scope of the "Dirt in Steel Mill Atmospheres" committee has been changed and it is now felt that it

is better illustrated by the title "Development of Data for Steel Plant Filters," as this is the problem which was the original reason for setting up the committee. Mr. A. H. Arbogast, combustion engineer of the Bethlehem Steel Co., is the new chairman on this committee, and he has called the first meeting of his sub-committee which is taking place at this moment in one of the other rooms.

No work was done on the steel mill lighting project to speak of, inasmuch as our main function on this is to cooperate with the Illuminating Engineering Society in their overall industry project. Our phase is to help them with information on steel plant lighting.

Bob Graham's committee has been working on a subject called "Crane Limit Switches." This is a subject which has been of interest to the seven company exchange group, who have been very much concerned with failure in this type of equipment. A questionnaire has been sent to the members of this group in order to obtain data on the number of failures and their causes. Some of this data has been already received, but answers are still expected from some of the other members of the group.

Mr. McGranahan's committee on "Rolling Pressures and Power Requirements for Rolling Mills" concentrated their study on blooming mills. It was decided to concentrate on the blooming mill subject first, because it was felt that this subject would be the one on which most data would be available and one in which there would be less differences of opinion as to the torque and power requirements. However, much to our surprise, we found very appreciable differences in the results which were obtained by the various methods. The differences are so marked that we are planning before going any further to obtain operational data from various steel plants which will be used as a check on the computation methods. If necessary we are planning to make tests on a representative mill using oscillograph equipment to measure the following:

1. Energy input to d-c motor driving mill.
2. Energy input to induction motor.
3. Acceleration and deceleration.
4. Speed.
5. Cross-section and temperature of bloom entering pass.
6. Cross-section and temperature of bloom leaving pass.
7. Diameter of rolls in that pass.
8. Efficiency of induction motor and d-c motor.
9. Kind of steel rolled.

No standardization has been accomplished during the year on the flexible coupling project. The data which has been collected has been turned over to the AISE staff for tabulation and study. Possibilities for developing a standard are slight.

The "Handbook of Lubrication Standards" under the chairmanship of C. E. Pritchard is making progress. This book is now about 25 per cent written and most of the other necessary data has been obtained. We expect that it will be completed in about another year. C. E. Pritchard, as you know, has been developing a recommended practice for plain bearing design which he will discuss later. He has done a very thorough job on this subject and has come up with something which most of you will find of practical value. This will be published later in the Iron and Steel Engineer, and I suggest that you look this over carefully and extract it for your files at that time.

Mr. Schlossberg's committee on "Mill Motor Brake Standardization" has practically completed its work. This committee has been working with a NEMA group, and as of the present time, the group agreed on figures for torques, wheel diameters, wheel widths, lining widths, lining pressures, maintaining hole diameters and maintaining hole space. Blueprints have been prepared which show the dimensions of the new brakes and wheels, and a mail vote is now under way on the part of the AISE-NEMA committee.

I wish to take time here to congratulate them on the essential completion on what has been an extremely tedious, difficult and worthwhile job.

The Philadelphia Section had a meeting in which the possibilities of Standards of Low Voltage A-c Control was discussed. Following their lead the Standardization Committee asked Mr. H. H. Angel to act as chairman.

After the membership of the Committee was determined, efforts were made to have an initial meeting in August or early September. This was impossible due to interference from summer vacations. It was decided to send out a questionnaire containing 31 items, in order to reveal the opinions and practices of the members and the companies they represent.

This data has been received and roughly tabulated. The information reveals that there is a fairly common agreement on a number of items, including considering standardized measurements for combination starters, the use of control transformers and standard spacing for contactors. It is planned to have the first meeting at an early date to discuss the various phases of this problem, and to prepare data which can be submitted to representatives of NEMA at a later meeting.

In closing, all members of the Standardization Committee are to be congratulated on their accomplishments during the year.

AISE CARBON BRUSH STANDARDIZATION (Progress Report)

By ERIC ANDERSON

Chairman

AISE Committee on Size, Length, Breadth and Type of Shunting for Motor Brushes

▲ THE report on the subject of Carbon Brush Standardization will be in the nature of a progress report. The present committee consisting of myself as chairman, V. E. Schlossberg of Inland Steel, C. R. Evans of Republic Steel, I. N. Tull of Republic Steel, and J. Hanlon of Bethlehem Steel, has attempted to follow along with the program so ably prepared by the previous committee of which Hugh Conover was chairman.

The previous committee did an excellent job in securing and tabulating information from all the various companies. This data was published in the February 1950 issue of The Iron and Steel Engineer.

Up to the present, the present committee is not in a

position to set down a definite stand. There are quite a few questions to be settled and it is our earnest hope that some of the members in the audience will help this committee in resolving some of the problems at hand.

The standards are now being set up to include only brushes used on mill type and crane and hoist type motors.

For the present, it is the general purpose motors that are not being considered. If the standardization of brushes for the mill and crane type motors prove successful and applicable and there is enough demand for a standardization of the brushes used on industrial type motors, I believe that such a standard should be considered.

In tabulating the data published in the February 1950, Iron and Steel Engineer, the previous committee included 115-volt, 230-volt and 550-volt motors. The present committee felt that in order to start out with a more simple standard and a fewer number of brushes, and since they felt that the number of 115-volt and 550-volt motors in operation in the steel industry were of a relatively small percentage, that these two types of motors should be eliminated from the standard and consideration given, first, to a set of standards to cover 230-volt motors.

While it is essential in setting up a standard to make definite specifications, it is also necessary to consider the problems of the manufacturer of the brushes and the designer and manufacturer of the motor using the brushes. The specifications must not be of a nature that would prevent development of improvement, neither must they be written to work a hardship on or favor any one manufacturer.

With these thoughts in mind, the committee is of the opinion that there are only three items pertaining to brushes which should be standardized, the size of the brushes, the length of the shunt, and the size of the terminal screw on the brush handle.

At the recent meeting held with the representatives of the three manufacturers of the 600 series mill type motors ranging from size 2 to 618, it was possible to set up 14 brushes which will cover the 11 frames.

Consideration has also been given to the establishment of a code number for designating the brushes which would indicate the size of the brush. In other words, the thickness, width, and length would be converted to sixteenth of inches and arrange to form the code number.

For example, Code No. 042024 would indicate a brush ¼ inch thick, 1¼ inches wide, and 1½ inches long.

You will notice that this designation of thickness, width, and length is a reversal of the system now in use. It is felt desirable to list the brush sizes in this manner as in the tabulating of different sizes of brushes, you are concerned particularly with the thickness and width; the length can be variable.

There has been no attempt made to standardize brush grades since it is felt that this is a problem which must be left in the hands of the manufacturers.

There was considerable discussion as to the desirability of standardizing the type of connection between the shunt and the brush, the size and location of the shunt and whether or not saddles or clips should be used.

These are questions which are controversial and are the ones which the committee would appreciate some expressions from the members present.

It is felt that by setting up standards to cover the size of the brush, the length of the shunt and the terminal screw, and possibly limit the shunt locations to positions 1, 2, 3, 7, 8 and 9, that the rest of the job would be well handled by the brush manufacturers.

I understand that quite a bit of development work is being done on the advancement of producing satisfactory tamp shunt connections and that improvements are being made on the riveted type connections. The size of the shunting is dependent upon the grade of the material and it is thought that with these items being left up to the brush manufacturers, they would be in a position to provide a brush of standard dimensions that would suit our needs and still allow for improvements and will maintain competition in the industry.

The committee would appreciate any comments on this report.

DISCUSSION

PRESENTED BY

FRANK W. CRAMER, Consulting Engineer, Elliott Co., Pittsburgh, Pa.

ERIC ANDERSON, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

J. S. AHRENS, Manager Carbon Brush Division, Union Carbide & Carbon Corp., Cleveland, Ohio

HARRY H. ANGEL, Electrical Engineer, Construction & Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

M. B. ANTRIM, Superintendent Electrical Maintenance, Lukens Steel Co., Coatesville, Pa.

DONALD R. WILCOX, Sales Engineer, Morganite, Inc., Cleveland, Ohio

Frank W. Cramer: I think the committee did a good job. My only suggestion on further standards is that they set a minimum size for the screws, so that if you have an arm with ordinary strength and a screwdriver it will be ample.

Eric Anderson: One-quarter inch is the minimum.

J. S. Ahrens: Our comments correspond almost exactly with the opinions expressed by Mr. Anderson. While some of us in the brush business today might prefer riveted shunts and others might prefer tamped shunts, and others still another type, only by leaving the type of connection and the type of location open to progress can the best brushes be achieved over a long period of time.

However, definite standards applied to terminals, shunt length, and especially brush length (as recommended by Mr. Anderson) are certainly desirable. We have been building such standardization, from the brush manufacturer's standpoint, for a long time. Therefore we are very happy to see the AISE taking such a step forward — in eliminating the unnecessary multiplicity of varying specifications of this kind.

Harry H. Angel: I do not think we ought to pin the manufacturers down too much in the design of the shunt. This will allow them a certain leeway, perhaps to produce a better competitive brush.

M. B. Antrim: I should like to back up Mr. Angel's statement in detail to the effect that the type of shunt used should not be rigidly specified and also the construction of the brush shunt should be allowed to de-

pend upon the particular application. For example, certain applications will require insulated shunts while others will operate satisfactorily with bare shunts. In order to avoid having uneconomical standards which in this case would mean having all shunts insulated, it would perhaps be better to allow this point some flexibility.

Brush size for a thoroughly tested and tried design of machine can no doubt be standardized and to our mind such standardization would be very beneficial however we believe only minimum standards can be adopted for other brush specifications.

Donald R. Wilcox: I know my company feels that the standardization should not include the riveted connection. It would be best to leave it up to the individual steel companies or the brush companies whether or not to use this connection. We have run riveted brushes and brushes with our new tamped connection on what we call the "bouncing betty." This is a 10-in. ring with four flats 0.050 in. deep. This ring is run at 1100 rpm and brushes operating on it are subjected to extreme vibration. This provides a severe test for the shunt connection. The new type tamped connection has proven on this test to be superior to the best riveted connection. It is stronger mechanically, and the millivolt drop across the connection is lower than across the riveted connection. We have found the new tamped connection will hold to the point where the shunt will break off due to the extreme vibration, while the connection itself remains sound.

I think the committee would be wise if it allowed the brush companies freedom on this point of tamped versus riveted connection.

AISE RECOMMENDED PLAIN BEARING DESIGN PRACTICE

By C. E. PRITCHARD

Chairman

AISE Plain Bearing Committee

▲ COMMITTEE: C. E. Pritchard, Republic Steel Corp., Chairman; H. H. Wood, Morgan Construction Co.; H. Smith, Federated Metals Division, American Smelting & Refining Co.; D. Whitehead, Crucible Steel Co.; O. Riss, Cleveland Graphite Bronze Co.; and W. Hyde, Wheeling Steel Corp.

1. *Purpose* — The purpose of this project is to correlate the available data covering the fundamental requirements of good bearing practice with additional data developed specifically for the steel industry. This information when properly disseminated should be helpful to persons responsible for the design, operation, and maintenance of properly lubricated journal type plain bearings.

2. *Scope* — The selection of a bearing material is actually, in most cases, a compromise because no single composition has been found which will have perfect performance for all bearing applications. In making the most desirable selection, the designing engineer or maintenance man must first have a thorough knowledge of the relative importance of the requirements for satisfactory service. In addition, he must also understand the limitations of the numerous available materials and select the one that best meets these established requirements.

In discussing and evaluating bearing requirements, a number of pertinent facts must be considered, including the fundamentals of bearing friction; beneficial effects of lubricants on the bearing surface; principles of good design and machine practice for plain bearings; length to diameter ratio limitations; clearance to diameter ratio limitations; fundamentals of oil film formation; fundamentals of oil grooving; bearing calculations; relative load carrying capacities of the various types of plain bearings; bearing material properties; recommendations for the pouring and casting of bearings; bearing load ratings; method for converting oil viscosities from one system to another; viscosity temperature relationship; bushing mounting fundamentals; typical bearing applications; coolant water and heat generation calculations for composition bearings; surface finish limitations; bearing design influence on machine vibration and fundamentals of sealing practices. These specific items will be covered in some detail throughout the project in order that a better understanding of the factors, upon which optimum bearing performance depends, can be more clearly recognized by those individuals charged with the responsibility for satisfactory bearing service in the steel industry.

The coefficient of friction of dry surfaces will vary with the type of material used in the bearing and the mating shaft, the surface finish and the degree of cleanliness at the respective contact surfaces. When the two objects are a rotating shaft and a stationary bearing rather than two sliding surfaces, the frictional force will be a tangential force on the shaft tending to retard its rotation.

Under moderate pressures, the frictional force is proportional to the normal load on the rubbing surfaces. It is conceded as being independent of the pressure per unit area of the surfaces. When the rubbing speed is of low velocity, the temperature of the surface is not generally affected and the coefficient of friction is approximately independent of the rubbing speed. At higher velocities it is found that the coefficient of friction decreases as the velocity increases.

Fluid lubrication of plain bearings will be governed to a major extent by the viscosity of the lubricant, the bearing clearance and length to diameter ratio, rubbing velocity of the shaft and applied unit load. To a minor extent it will be dependent of surface finish, principally whenever the region of boundary lubrication is approached. The wedge-shaped film which is formed between the journal and the bearing provides a hydrostatic pressure sufficient to float the journal and carry the load applied to it.

The coefficient of friction is found to increase rapidly when the ratio of bearing length to diameter is less than 0.75. The 0.75 L/D ratio may therefore be considered as a safe minimum ratio in bearing design. It being also found that a definite relationship exists between the coefficient of friction and the ratio of bearing clearance to the shaft diameter. When the C/D is less than 0.001,

the increase in value of the coefficient of friction is very rapid. For general bearing design, a value of 0.001 for the C/D ratio will give satisfactory results.

The fundamental basis of oil film formation is graphically illustrated. One salient point in this regard which might be emphasized is that where the unit load of the bearing is very high or the rubbing velocity of a low order, the lubricating film may not be established with a resultant metal to metal contact and bearing wear with a corresponding reduction in bearing service life.

The primary purpose of providing oil grooving is to direct the distribution of the lubricant within a given bearing, in such a manner as to promote the formation and maintenance of a separating and supporting film between the journal and the bearing. Any groove which performs this simple function is correct, and conversely any groove which induces the breakdown of the separating film and conducts the lubricant away from the pressure area is incorrect. This basic principle offers a positive guide to correct grooving practice.

Oil grooves should be terminated at a predetermined distance from the end of the bearing to insure adequate lubricant distribution. Consideration must be given to the difference in mobility of grease versus oil which grooving designs are developed for plain bearings with wider grooves allowing greater adhesion of the grease to the rotating shaft due to greater contact area. Feeder grooves are necessary on large diameter bearings where grease is employed as the lubricant. Grooving and sealing tables are offered for consideration.

Bearing calculations are provided along with tables of values covering $\frac{ZN}{P}$ and factor of safety. The tables were developed on the basis of general practice employed in bearing design throughout the steel industry.

A conclusion is drawn from a recent mathematical study of the various bearing types regarding their relative load-carrying capacity as presented by Messrs. Stone and Underwood. General Motors Research Laboratories. Their findings together with a summary table are offered as a reference guide for the many and varied field applications of plain bearings.

To perform satisfactorily as a bearing material, the metal must have certain essential characteristics both with respect to the lubricant used and the type of metal employed in the journal. For many years in the past, metals used in bearings were judged by a relatively few mechanical properties such as compressive strength, elongation and hardness. It is now recognized, based upon several independent studies, that such additional properties as fatigue resistance, non-scoring characteristics, conformability, embedability, corrosion resistance and bonding characteristics are of equal importance if satisfactory service life is to be realized. Recommendations for the pouring and casting of bearings are also believed to be mandatory for good operating practice. Tables covering the properties of pure metals, relating to their bearing properties and bearing load ratings of the more common materials found in general use are offered as an adjunct to the other recommendations for the selection of a given bearing material.

ASTM viscosity conversion tables are included to permit the calculation of load carrying capacities for full fluid film lubricated journal bearings together with minimum acceptable values for the many and varied bearing applications.

Bushing mounting suggestions are projected as a means of overcoming common errors introduced by lack of consideration of the thermal expansion properties of the metals employed. Considerable benefits are made possible whenever a complete and thorough understanding of the respective thermal expansion properties of the bearing materials are known and the design developed to suit.

A brief and concise description of the generally accepted practice in bearing material selection for miscellaneous bearing applications of auxiliary equipment such as mill motors, turbines, etc., is offered to better acquaint the reader with such coverage in the steel industry.

Composition bearing installations in the steel industry have assumed an important position especially in such applications as roll neck bearings. Successful operation of this type bearing demands that the temperature limitations, thermal conductivity, resiliency, etc., of the installation be thoroughly understood. Water, being the most common coolant and lubricant employed with this type of bearing material, is found to have a viscosity of only one. Figures are presented which show the viscosity of water as a function of temperature and indicate that the viscosity is cut in half by raising the temperature from 20-50 C (68-122 F). Where high pressures are encountered together with the high water temperature, a rupture of the film is noted resulting in increased bearing wear and possible total destruction. Suggestions are offered for calculating quantities of water desired together with heat generation for composition bearings.

Carbon-graphite bearing installations are covered in the same manner as composition bearings. Due to porosity relationships encountered with this type bearing material, an explanation of this characteristic is included.

Flood lubricated oil film bearings are essentially totally enclosed precision type plain bearings. They embody a type of construction in which the assembly is removable as a complete bearing unit. Due to their high load carrying capacity, they are employed as roll neck bearings on various types of hot and cold rolling mills in the steel industry. A resume of their type of construction and lubrication requirements is offered so that a better understanding of their qualifications can be realized.

Bearing design is found to have a profound effect on critical machinery due to self induced vibration which very often leads to damage to the vital operating members. Poor alignment of plain bearings contributes heavily to such hazardous conditions. An explanation is given as to the phenomenon involved where either oil-whip or sub-harmonic resonance are encountered.

In many machine designs, little or no thought is given to the incorporation of sealing devices in plain bearing applications as a means of controlling loss of lubricant or the infiltration of foreign contaminants. Seals for rotating shafts include several distinct forms and the range of their respective usefullness should be thoroughly understood. A brief resume of the several types of sealing devices and materials is given together with recommendations as to their respective limitations.

Although this coverage is by no means complete, it is hoped that by pointing out salient facts pertaining to the correct selection of the sealing material most suitable for the application in question a better approach to this important and often neglected subject will be forthcoming.

REPORT ON MILL MOTOR STANDARDIZATION

By M. B. ANTRIM

Chairman

AISE Mill Motor Committee

▲ Approximately three years ago, the Association of Iron and Steel Engineers, together with the electrical manufacturers, performed a very exceptional job of close cooperation in developing and producing the new "600 Series" mill type motor, which is described in AISE Standard No. 1.

Last year, a report of the crane wiring standards committee, pointed out that there was a marked difference in the lead sizes used by the different electrical manufacturers on mill type motors. In fact, this lead size difference was so marked that in certain cases users were taking the manufacturers' motor and rewiring it, changing the lead sizes before installation. This, of course, was poor practice, and it was brought to the attention of the AISE by a number of people.

Since that time there has been a revision of the lead sizes, until we now have a table of present sizes of mill type motor leads which is shown in Table I.

The table lists three manufacturers: "A, B, and C" and shows the frame sizes for mill type motors in the column at the extreme left. Under each manufacturer is shown the wire size and circular mill area for each motor frame size.

Shown on the right hand side of the table are the shunt field leads and their various sizes for each manufacturer and motor frame size.

Manufacturer "A" uses copper bar leads, for the last three frame sizes of mill motors. These bar leads are shown for the frames No. 614, No. 616, and No. 618.

Manufacturer "B" uses bar leads for the last two sizes, or the largest frames of mill motors, while Manufacturer "C" uses cable leads throughout.

It is the feeling of the mill motor committee that as long as the leads are adequate, both electrically and mechanically, there can be no complaint. However, you will note in connection with the shunt field leads, there is a very marked difference in size, ranging all the way from No. 12 wire to No. 5 wire.

The crane wiring committee has set a minimum standard in wiring of No. 8 wire or better for mechanical reasons, and it is the feeling of the mill motor committee that this standard should be met by the various manufacturers in connection with mill motor shunt field leads for the same reason.

We have already obtained approval for the change of those leads smaller than No. 8 wire, as shown in the shunt field lead listing in Table I, to No. 8 wire.

There have been various comments regarding the use of bar leads for the main leads of the largest sizes of mill type motors, the objection being that in the case of motors which are removed and replaced rather frequently, bar leads are more subject to damage and much more difficult and expensive to repair than are cable leads.

We would point out, however, that the two largest sizes of mill type motors, frames No. 616 and No. 618, are of such a size that they are relatively out of the common variety of auxiliary mill type motors. In other words, these motors would be used largely for main drives, and would be motors which are not replaced frequently.

There is some question on frame No. 614 of Manufacturer "A," and this has already been agreed to be changed to a cable lead, providing the membership of the AISE so desires.

We would, therefore, request the membership of the AISE, who have any comments to make regarding these lead sizes, to give them to us at this time.

TABLE I

PRESENT WIRE SIZES ON MILL MOTOR LEADS

Frame	Main leads						Shunt field leads		
	Mfg. A		Mfg. B		Mfg. C		Mfg. A	Mfg. B	Mfg. C
	Wire size	Area CM	Wire size	Area CM	Wire size	Area CM	Wire size	Wire size	Wire size
602	6	26,250	8	16,510	6	26,250	6	12	10
603	6	26,250	8	16,510	6	26,250	6	12	10
604	5	33,100	6	26,250	6	26,250	6	12	10
606	2	66,370	3	52,640	4	41,740	6	12	10
608	1	83,690	1	83,690	2	66,370	6	12	10
610	1/0	105,500	1/0	105,500	1/0	105,500	6	12	8
612	3/0	167,800	3/0	167,800	3/0	167,800	6	12	8
614	2 3/32 x 1 1/4 in.	298,414	4/0	211,600	250MCM	250,000	6	12	8
616	2 1/8 x 1 3/8 in.	437,674	2-1 1/4 x 0.094 in.	299,210	2-3/0	335,600	5	12	8
618	2 1/8 x 1 1/2 in.	477,464	2-1 1/2 x 1/8 in.	477,464	2-250MCM	500,000	5	12	8

DISCUSSION

PRESENTED BY

E. L. ANDERSON, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

M. B. ANTRIM, Superintendent Electrical Maintenance, Lukens Steel Co., Coatesville, Pa.

E. L. Anderson: As I recall, Table I indicates the use of No. 3/0 wire and No. 5 wire for motor leads. As these are an odd size wire to the average mill electrical storeroom, I would like to suggest that the next larger size wire be used in each case. No. 4/0 wire and No. 4 wire are more or less standard and are readily obtainable in most repair shops.

M. B. Antrim: It seems fitting that a questionnaire be prepared regarding the request brought forth by Mr. Anderson and also to settle several other points at issue in connection with these lead sizes. This questionnaire, when prepared, will be circulated throughout the industry for your comments.

In this way we will be able to determine just what your wishes are in respect to this matter of the standardization of mill motor leads.

AISE SPECIFICATION FOR DESIGN OF HOT METAL LADLES

By I. E. MADSEN

AISE Standards Engineer

▲ UNFORTUNATELY Professor Bruce Johnston, who was to report on the Specifications for Hot Metal Ladles is ill in the hospital and I am going to pinch hit for him in his absence. This report was not written by him so it may contain some views which are not entirely in accordance with his thinking, but we are going to report to you what we have been able to deduce from his reports to us and from the draft specification.

Two years ago, Mr. Knudsen and Professor Johnston of the Fritz Engineering Laboratory of Lehigh University reported to you the results of a very extensive research project involving the stress analysis of hot metal ladles. The work reported was very thorough and covered in general a solution to the problem of how to figure the stresses in the rings and trunnion bands of such ladles. The stresses were also at that time measured in the side plates and bottom plates of the ladles which were tested. However, the primary emphasis of the research project was concentrated on the complicated analysis of the bands, inasmuch as the stresses in the side and bottom plates are analogous to those in pressure vessels and also because a great deal of current research has been going on in the field, which our group could take advantage of as it is reported and published in the literature.

The analysis of the stresses in the hot metal ladle is an extremely difficult problem. As a result, the data and the proposed analysis which was developed by Lehigh two years ago was rather complicated and abstruse, so much so, that it was felt that it was rather impractical to incorporate it in a steel mill specification. As a result, it was therefore decided by the hot metal ladle committee that an attempt should be made to simplify the analysis so that it could be put on a more practical basis. It was also decided to hire Professor Johnston to continue with the work of simplifying the results and to write the practical specification. I am very happy to report that Professor Johnston has succeeded in this.

One of the very helpful factors in this work has been the make-up of the hot metal ladle committee. Major steel companies have been represented on the committee as well as representatives of all the hot metal ladle manufacturers. As a result of their experience, advice and guidance, a specification has been developed which is in accordance with the best judgment of the group. The chairman of the committee is Fred Kling of Tenafly, N. J. The Bethlehem Steel Co. is represented by Leo Gould, chief engineer of construction and Mr. Leermachers, their structural engineer; Carnegie-Illinois Steel Corp. is represented by William Mursch of the Engineering Department. Mr. Fred Kling, as you know, is also retired from Carnegie-Illinois. Republic Steel Corp. is represented by Leonard Larson, chief engineer here in Cleveland. The ladle manufacturers are represented by F. L. Lindemuth, chief engineer of the Wm. G. Pollock Co., Harry McFeaters, chief engineer of the Pennsylvania Engineering Co. and W. W. Wallace of Treadwell.

I will not attempt to read the specifications in detail at the present time, but will just point out some of the highlights. Over 200 pages of calculations form the basis of this specification and about 40 actual ladles have been studied and analyzed in their development. The procedures are safe though not unduly conservative, inasmuch as with present expansion we are attempting to increase capacity of various types of equipment where we can safely do so. The procedure is not complicated and all the basic rib and plate thickness requirements can be designed in less than two hours for a given ladle, and this any engineer should be able to do after he once has become familiar with the specification.

This specification which was prepared by Professor Johnston was acted upon by the Hot Metal Ladle Committee on September 15, 1950. At this meeting there were the usual revisions and the specification was approved as revised by the committee at this meeting. It will be known as AISE Standard No. 9 "Specifications for Design of Hot Metal Ladles." The tentative standard will be published in detail in the Iron and Steel Engineer. Formulae from the specifications were arrived at from the theoretical considerations coupled with various allowable unit stresses selected in the light of the state of stress in the Section as well as its reserve strength. A process of repeated simplification preceded the development of each design formula, the aim being to achieve the maximum simplicity possible as an aid to the designer.

The results of this study indicate that ladles are in general well designed as they are now manufactured, irrespective of whether or not a great amount of analysis was carried out as a preliminary. Many years of trial and error have evolved good proportions. The design formulae of the specification result in proportions similar to those now obtained in practice. The design formulae were not arrived at by working backward from existing practice, but, as mentioned before, are based on theoretical considerations.

The development of the proposed procedure for calculating maximum stresses in the stiffening ribs is a further simplification of the procedure previously proposed as a result of the research carried out at the Fritz Engineering Laboratory of Lehigh University. The agreement between the design procedure and experimentally measured stresses is even better than in the

earlier more complicated procedure, especially with respect to the larger and most critical stresses.

The materials selected for the specifications are the standard ones now used for the plates which are in accordance with ASTM A 7 Structural and A 285 for flange quality carbon steel. The specifications could be used, if so desired, for higher strength materials by changing the formulae proportionately for the higher allowable fiber stresses. Construction details are in accordance with what is considered good practice in ladle design.

The sidewall thicknesses are specified by giving a minimum. It so happens that these plate thicknesses are not governed by the direct stresses which are low and are proportioned in general from experience.

One of the unusual features of the specification is that the allowable stress varies depending on the type of stress. Sections which are carrying a uniform load have a maximum stress of 8000 psi. Sections subjected to bending or combined bending and direct load have an allowable stress of 16,000 psi. A maximum value of 24,000 psi is used for stresses which do not carry load but are due to stress raisers or stress concentrations.

In the design of the ladle bottoms, advantage is being taken of the latest developments in pressure vessel design. As you may know a great deal of research and development work is being carried out by the ASME for their pressure vessel and boiler code work. Some of this has also been handled at Lehigh where Professor Johnston was located, particularly some of the formulae for bottom plate thicknesses have been developed from this work. The calculations for the ribs are based entirely on the work carried out by the Association of Iron and Steel Engineers. The resulting work checks very well with the existing practice on satisfactory ladles and with the test results. This is shown in the following figures. Figure 1 gives comparison between design formulae and bottom thicknesses of circular flat bottom ladles. The straight line on the right is a plot of the combined thicknesses of the reinforcing and bottom plates. The circular dots show how the thickness of existing ladles falls with respect to that line. Note that most of these are to the left indicating that the design is on the safe side. The curve in the center is the one

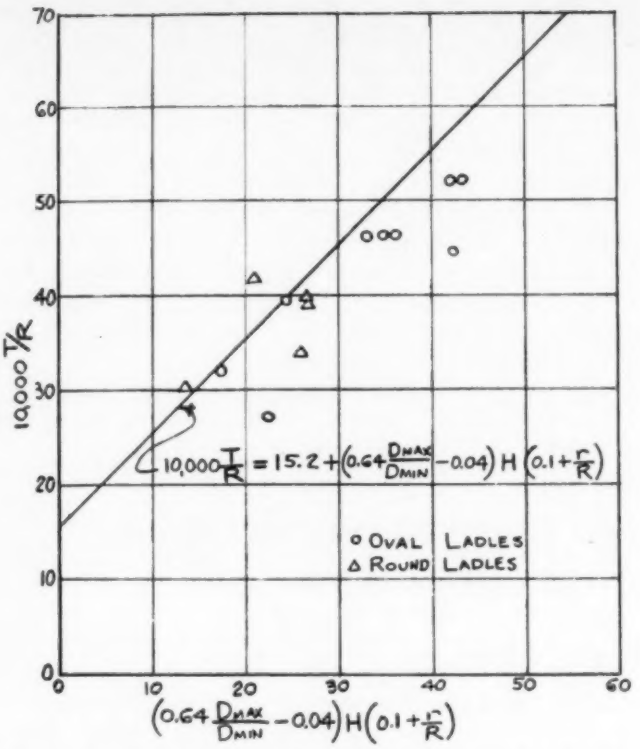

10,000 T/R
$10{,}000\frac{T}{R} = 15.2 + \left(0.64\frac{D_{MAX}}{D_{MIN}} - 0.04\right) H \left(0.1 + \frac{r}{R}\right)$
o OVAL LADLES
Δ ROUND LADLES
$\left(0.64\frac{D_{MAX}}{D_{MIN}} - 0.04\right) H \left(0.1 + \frac{r}{R}\right)$

Figure 1 — Graph gives total bottom thickness for circular flat bottom ladles based on 18,000 psi stress.

which applied to single plate bottom ladles and these are of course only used in these smaller units. The upper curve has been developed from the specification and gives the total bottom plate thickness of a reinforced bottom.

It is very much in line with existing practice except for one point and it will be noted that this particular ladle had to have its bottom replaced after several years of service.

Figure 2 is a similar curve for dished bottoms. The curve as shown was developed for an 18,000 psi stress, however, the committee on their work on September 15, 1950 adopted 16,000 psi which shifts the curve to the right and also more closely through the center of gravity of the points.

TABLE I

STRESSES DETERMINED BY PROPOSED DESIGN METHOD APPLIED TO VARIOUS FULL SIZE LADLES

			Actual ladle designs in service					Sample design example
Ladle mfg.			C	C	A	B	A	
Ladle capacity in tons			70	140	200	225	270	150
Top rib	0°	Out	—39,000	—36,400*	—**	—16,750	—**	—13,500
		In	+19,700	+19,000	—**	+10,300	—**	+ 3,130
	At change of section	Out	.....	.....	—15,600	—12,100	—16,700	—15,500
		In	.....	.....	+10,000	+ 6,500	+10,600	+ 8,400
	90°	Out	+16,000	+ 5,540	+ 7,800	+13,800	+ 4,600	+13,100
		In	— 9,200	— 4,010	— 5,900	— 7,550	— 3,650	— 7,950
Bottom rib	90°	Out	+10,500	+ 4,250	+ 6,100	+ 8,900	+ 4,800	+ 9,600
		In	— 6,800	— 3,230	— 4,700	— 5,500	— 3,450	— 6,700

*Section was reduced for hook clearance.

**Stress obviously greater at change of section.

TABLE II

STRESSES IN TEST LADLE A

(Round, Riveted, with Flat Stiffener Bands)

Location			2½-in. Hook distance 8 x 8 Trunnion pads		2½-in. Hook distance 8 x 16 Trunnion pads		7½-in. Hook distance 8 x 16 Trunnion pads	
			Test	Formula	Test	Formula	Test	Formula
Lip ring	0°	Out	—10,800	—10,900	— 6,850	— 8,750	—12,200	—14,300
		In	+28,400	+25,900	+23,400	+20,750	+33,600	+34,000
	90°	Out	+ 4,800	+ 5,400	+ 4,010	+ 5,400	+ 7,730	+ 8,900
		In	—15,500	—14,200	—17,990	—14,200	—29,770	—23,400
Top rib	0°	Out	— 6,450	— 7,300	— 2,180	— 5,900	— 4,360	— 9,700
		In	+ 3,500	+ 5,600	+ 1,600	+ 4,400	+ 3,400	+ 7,300
	90°	Out	+ 3,740	+ 3,800	+ 3,450	+ 3,800	+ 5,570	+ 6,300
		In	— 1,820	— 3,000	— 2,010	— 3,000	— 3,120	— 4,900
Bottom rib	90°	Out	+ 4,600	+ 3,100	+ 4,220	+ 3,100	+ 7,570	+ 5,200
		In	— 1,340	— 2,700	— 1,910	— 2,700	— 4,150	— 4,400

TABLE III

STRESSES IN TEST LADLES

TEST LADLE B — (Oval, Welded, Uniform Side Wall Thickness)

Location			2½-in. Hook distance		7½-in. Hook distance	
			Test	Formula	Test	Formula
Lip ring	0°	Out	.....	—10,260	.....	—17,500
		In	+ 9,160	+13,200	+18,100	+22,600
	90°	Out	+ 2,750	+ 4,260	+ 5,800	+ 7,270
		In	— 6,330	— 5,950	— 7,580	—10,130
Top rib	0°	Out	— 9,970	—11,000	—22,400	—18,800
		In	+ 3,620	+ 5,580	+ 6,900	+ 9,500
	90°	Out	+ 3,390	+ 4,560	+ 6,450	+ 7,790
		In	— 1,880	— 2,600	— 4,220	— 4,430
Bottom rib	90°	Out	+ 4,290	+ 4,600	+ 8,500	+ 7,850
		In	— 3,310	— 3,700	— 6,060	— 6,320

TEST LADLE C — (Round, Welded, Side Wall Thickened Between Ribs)

Location			2½-in. Hook distance		7½-in. Hook distance	
			Test	Formula	Test	Formula
Lip ring	0°	Out	— 9,150	— 9,350	—18,500	—15,430
		In	.....	+12,460	.....	+20,580
	90°	Out	+ 3,540	+ 5,420	+ 6,020	+ 8,960
		In	— 5,930	— 7,230	— 9,500	—11,920
Top rib	0°	Out	— 3,100	— 4,220	— 6,740	— 6,960
		In	+ 3,700	+ 3,600	+ 7,300	+ 5,950
	90°	Out	+ 5,250	+ 7,290	+ 9,250	+12,030
		In	— 3,400	— 3,610	— 5,700	— 5,960
Bottom rib	90°	Out	+ 4,180	+ 4,140	+ 4,430	+ 6,840
		In	— 2,340	— 2,070	— 4,430	— 3,420

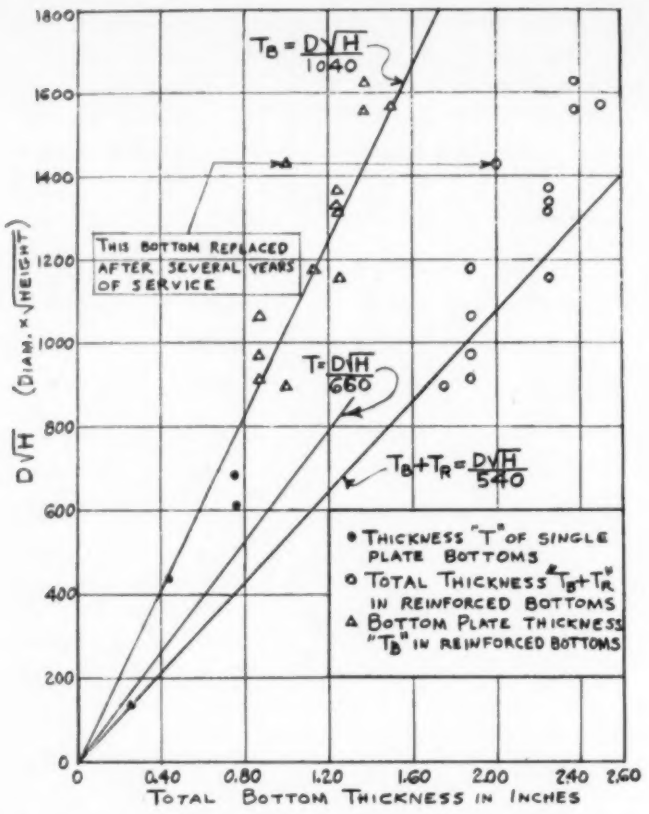


Figure 2 — Drawing gives thicknesses of dished bottom ladles based on a stress of 18,000 psi.

Table I shows what type of stresses are obtained by the analysis on present ladles. It is seen that most of the stresses are reasonable with the exception of some on the top rib. In one case the section was here reduced for hook clearance and in another there was a stress concentration due to change in section.

Table II was made to compare computed stresses with actual stresses on the ladles in the research investigation. The comparison is quite close on a percentage basis particularly in the case of the higher and consequently more important stresses. Table III is a similar comparison for the other two ladles in the research investigation.

I would like to conclude by complimenting Professor Johnston and the committee on their work. This final revised method is not only simpler than the original, but also gives better and more accurate results.

WIRING STANDARDIZATION

(Progress Report)

By C. G. DIMITT

Co-chairman, AISE Wiring Committee

▲ AT the 1949 convention in Pittsburgh, the Crane Wiring Committee was given the additional assignment of standardizing auxiliary drive mill motor wiring, supplementing its activities on crane wiring. It has therefore seemed appropriate to change the name of this committee from Crane Wiring Committee to simply Wiring Committee.

The membership of this committee consists of:

J. E. Bodoh, United States Steel Co., Gary Steel Works.

C. G. Dimitt, United States Steel Co., South Works.

L. A. Wynd, Republic Steel Corp., South Chicago Works.

R. A. Daugherty, National Tube, Gary Works.

A. L. Schroeder, United States Steel Co., Gary Sheet & Tin Mills.

W. J. Tunny, Youngstown Sheet & Tube, Indiana Harbor Works.

R. W. Scheffler, United States Steel Co., Gary Steel Works.

C. A. Patterson, United States Steel Co., Gary Steel Works.

In order that the proposed activities of the Wiring Committee be better understood, an agenda has been prepared, as outlined in Table I.

The progress of the committee's work is as follows:

A. HEAVY DUTY MILL CRANE MILL MOTOR WIRING

The standards proposed by the Wiring Committee at the 1949 convention were approved as tentative standards and were published in the June 1950 Iron & Steel Engineer as AISE Tentative Standard No. 8, dated October 2, 1949.

These standards have been used as the basis for wiring a number of cranes. Available reports indicate that the standards have been satisfactory for installation purposes. Since no reports to the contrary have been received it is concluded that cable sizes have been found satisfactory. The committee desires any comments regarding installation or operating experiences resulting from the use of these tentative standards so that definite standards can be adopted.

The tentative standards contain three tables listing mill type motors. Table II gives a condensed list of standardized mill motors by the AISE 1949 and AISE 1940 frame sizes, by the manufacturer's frame sizes, and by the horsepower rating. Taking a given frame size say 610, the 1940 standard size is No. 12, the General Electric frame size is MD-412, the Westinghouse frame size is MC-121, the Crocker-Wheeler frame size is SW-50, the 1 hour rating is 50 hp, and the ½ hour rating is 65 hp. Thus, complete identification is given for each frame size.

Table III gives a condensed list of General Electric, Westinghouse, and Crocker-Wheeler mill motors made before the AISE standardized mill motor was developed. These motors are listed by the manufacturer's frame sizes and by the horsepower rating. For a given frame size say AW, the manufacturer is Crocker-Wheeler, the 1-hour rating is 8 hp, and the ½ hour rating is 10 hp.

Alternate table for Table II and Table III lists mill motors by horsepower rating. The ranges shown include all of the frame sizes listed in Table II and Table III. It will be noted that the first column gives the motor horsepower range which will utilize a given size of conductor cable. That is, in the range of 28 to 40 hp,

TABLE I

AGENDA-WIRING COMMITTEE

A. STANDARDIZE HEAVY DUTY MILL CRANE MILL MOTOR WIRING.

B. COOPERATE WITH MILL MOTOR STANDARDIZATION COMMITTEE IN STANDARDIZATION OF MOTOR FRAME LEAD SIZES.

C. STANDARDIZE MILL AUXILIARY DRIVE MILL MOTOR WIRING SUPPLEMENTING CRANE WIRING.

D. STANDARDIZE TYPES OF CONDUIT, FITTINGS, INCLUDING INSULATED BUSHINGS, JUNCTION BOXES AND THEIR LOCATIONS.

E. STANDARDIZE METHODS OF WIRING, INCLUDING INSULATION AND SEGREGATION IN JUNCTION BOXES, AT MOTORS, PANELS, AND RESISTORS, AND MARKING OR IDENTIFICATION OF CIRCUITS.

F. STANDARDIZE RESISTOR CONDUCTOR SIZES.

G. STANDARDIZE FRAME LEAD AND CONDUIT CONDUCTOR TERMINALS.

H. STANDARDIZE FEEDERS FROM MAIN DISCONNECT TO MAIN COLLECTORS, TO PANELS, TO CRANE CAGE BREAKER, AND INTERPANEL FEEDERS.

I. STANDARDIZE FEEDER SIZES TO CRANE RUNWAY FEEDER RAILS.

ITEMS UNDER CONSIDERATION BY THE WIRING COMMITTEE FOR POSSIBLE STANDARDIZATION:

J. STANDARDIZE TYPES AND SIZES OF MAIN DISCONNECTS, CAGE BREAKERS, AND THEIR LOCATION.

K. STANDARDIZE INSTALLATION DETAILS AND ARRANGEMENT OF MASTERS, PANELS, RESISTORS, COLLECTORS, ETC.

L. STANDARDIZE RESISTOR BOX SIZES.

TABLE II

AISE WIRING STANDARDS — AISE D-C MILL MOTOR

Motor frame data					Motor frame ratings				Average intermittent duty service		Heavy intermittent duty service	
AISE 1949	AISE 1940	General Electric	Westing-house	Crocker-Wheeler	Hp 1 hr	Amp 1 hr	Hp ½ hr	Amp ½ hr	Condr size, per leg	Conduit number and size, in.	Condr size, per leg	Conduit number and size in.
2	2	MD-402	MC-21	SW-5	5	21	6½	29	8	1—1¼	8	1—1¼
602	3	MD-403	MC-31	SW-7½	7½	31	10	44	8	1—1¼	8	1—1¼
603	4	MD-404	MC-41	SW-10	10	40	13½	57	8	1—1¼	8	1—1¼
604	6	MD-406	MC-61	SW-15	15	57	19	77	8	1—1¼	6	1—1¼
606	8	MD-408	MC-81	SW-25	25	95	33	126	4	1—1½	2	1—2
608	10	MD-410	MC-101	SW-35	35	132	45	175	2	1—2	1	1—2
610	12	MD-412	MC-121	SW-50	50	185	65	245	1/0	1—2	2/0	1—2½
612	14	MD-414	MC-141	SW-75	75	272	100	368	3/0	1—2½	4/0	1—2½
614	16	MD-416	MC-161	SW-100	100	360	135	500	250	1—3	300	1—3
616	18	MD-418	MC-181	SW-150	150	540	200	740	400	2—3	500	2—3
.....	..	.....	.....	.....	...	...	...	...	2—3/0	2—2½	2—250	2—3
618	..	MD-420	.....	.....	200	730	265	960	2—250	2—3	2—300	2—3

all motor frames will use a No. 2 conductor for heavy duty service and a No. 4 conductor for average duty service.

Of 100 questionnaires sent out requesting comments and preference for these tables, only twenty-seven replies were received. Of the twenty-seven, twenty-five favored the standards, and two disapproved of a rigid standard. Of the twenty-five who favored the standard, eleven preferred the Table II and Table III method of listing. Fourteen favored the alternate table method. Since there was no decided preference for either method, the committee proposes to proceed on the basis of showing all pertinent information in the final standards.

During 1950, the activities of the Wiring Committee included attendance at the National Fire Protection Association Convention at Atlantic City. That association sponsors the National Electrical Code through its Electrical Section. At the Atlantic City convention, the work of the Wiring Committee was presented to the Electrical Section with a request for consideration of a revision of the National Electrical Code to include

TABLE III

AISE WIRING STANDARDS — MISCELLANEOUS D-C MOTORS

Motor data						Average intermittent duty service		Heavy intermittent duty service	
Frame size	Mfr	Hp 1 hr	Amp 1 hr	Hp ½ hr	Amp ½ hr	Condr size, per leg	Conduit number and size, in.	Condr size, per leg	Conduit number and size, in.
AW	C-W	8	37	10	50	8	1—1¼	8	1—1¼
102	G-E	9	33	12	50	8	1—1¼	8	1—1¼
30	West.	12	47	15	62	8	1—1¼	6	1—1¼
103	G-E	13	50	17	70	8	1—1¼	6	1—1¼
BW	C-W	16	56	20	86	8	1—1¼	6	1—1¼
40	West.	20	76	28	116	6	1—1¼	4	1—1½
104	G-E	20	77	30	124	6	1—1¼	2	1—2
C-W	C-W	25	88	30	112	6	1—1¼	4	1—1½
104½	G-E	30	112	45	175	3	1—1½	1	1—2
50	West.	30	114	40	157	3	1—1½	2	1—2
DW	C-W	36	138	45	180	2	1—2	1	1—2
105	G-E	40	154	50	200	1	1—2	1/0	1—2
EW	C-W	47	175	60	245	1/0	1—2	2/0	1—2½
60	West.	50	172	65	250	1/0	1—2	2/0	1—2½
FW	C-W	66	240	85	320	3/0	1—2½	3/0	1—2½
70	West.	70	255	90	346	3/0	1—2½	4/0	1—2½
106	G-E	70	264	85	324	3/0	1—2½	4/0	1—2½
107	G-E	85	316	110	432	4/0	1—2½	250	1—3
80	West.	85	320	110	410	4/0	1—2½	250	1—3
GW	C-W	90	310	110	400	4/0	1—2½	250	1—3
90	West.	100	360	140	520	250	1—3	300	1—3
108	G-E	100	365	140	565	250	1—3	300	1—3

our Standard No. 8. The Electrical Section has accepted this request, and the matter has been referred to their code making panels for study and recommendations.

The Electrical Section has invited a member of the Wiring Committee to serve on Code-Making Panel No. 12 which has within its scope the provisions of articles 610, 615, 620, 630, and 670 of the National Electrical Code. Acceptance of this appointment should facilitate the consideration of Wiring Standards by the code-making panels.

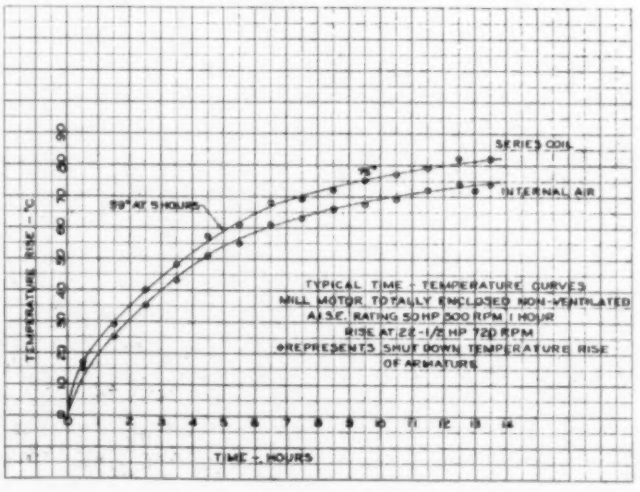
B. COOPERATION WITH MOTOR STANDARDIZATION COMMITTEE IN STANDARDIZATION OF MOTOR FRAME LEAD SIZES

The progress made in arriving at standard frame lead sizes has been covered by the report of Mr. Antrim, chairman of the Mill Motor Committee.

C. STANDARDIZE MILL AUXILIARY DRIVE MILL MOTOR WIRING

Some work was done during the year on auxiliary drive mill motor wiring. The Wiring Committee believed that if it were possible, it would be desirable to use the same wiring standard for both heavy duty crane

Figure 22 — Typical time-temperature curves for an AISE standardized mill motor running at rated load of 22½ hp for continuous operation.


SERIES COIL
INTERNAL AIR
99° AT 5 HOURS
TYPICAL TIME - TEMPERATURE CURVES
MILL MOTOR, TOTALLY ENCLOSED NON-VENTILATED
A.I.S.E. RATING 50 HP 500 RPM 1 HOUR
RISE AT 22-1/2 HP 720 RPM
REPRESENTS SHUT DOWN TEMPERATURE RISE OF ARMATURE
TEMPERATURE RISE - °C
TIME - HOURS

ALTERNATE TABLE FOR TABLES II AND III

WIRE SIZES FOR D-C MILL TYPE MOTORS

Motor frame data				Heavy duty intermittent service		Average duty intermittent service	
Hp ½ hour	Amp ½ hour	Hp 1 hour	Amp 1 hour	Conductor size, per leg	Conduit number and size, in.	Conductor size, per leg	Conduit number and size, in
5–13½	23–57	4–10	17–40	8	1—1¼	8	1—1¼
15–20	62–86	12–16	47–57	6	1—1¼	8	1—1¼
28–40	116–157	20–30	76–114	2	1—2	4	1—1½
45	175–180	30–36	112–138	1	1—2	2	1—2
50	200	40	154	1/0	1—2	1	1—2
60–65	245–250	47–50	175–185	2/0	1—2½	1/0	1—2
85–100	320–368	66–75	240–272	4/0	1—2½	3/0	1—2½
110	400–432	85–90	310–320	250	1—3	4/0	1—2½
135–140	500–565	100	360–365	300	1—3	250	1—3
160	590	120	440	350	2—3	300	1—3
200–225	730–840	150–175	540–640	2—250	2—3	500	2—3
250–265	900–960	180–200	660–730	2—300	4—3	2—250	2—3
325	1160	275	970	2—400	4—3	2—350	4—3

and mill auxiliary drive motor applications. In this connection, let us review some of the curves presented in the committee's report last year.

Consideration of Figure 22 of the 1949 report indicates that a typical frame 610 motor, operating at its continuous rating of 22½-hp, will have a temperature rise rather steeply for about five hours (300 minutes) and then will level off.

Likewise, in Figure 2, three 1/0 conductors operating at their continuous rating of 140 amperes, will have a temperature rise rather steeply for about 2 hours (120 minutes) and then will level off. These two curves indicate that for continuous duty, conductors in conduit and mill type motors have similar temperature rise characteristics.

Figure 21 shows the frame 610 temperature rise characteristics for 30 minute and 60 minute ratings.

In Figure 23, the frame 610 temperature rise for the 60 minute rating has been matched with the temperature of four 1/0 conductors carrying 187 amperes. The 1/0 conductor is the size recommended by the Wiring Committee for the 610 frame for average intermittent duty service. The temperature rise of 39 C in sixty minutes gives an operating temperature of 69 C with an ambient of 30 C.

In Figure 24, the frame 610 temperature rise for the

Figure 2 — Result of first test made in 1949 to investigate the method used in 1918. This test was made on three 1/0 conductors.

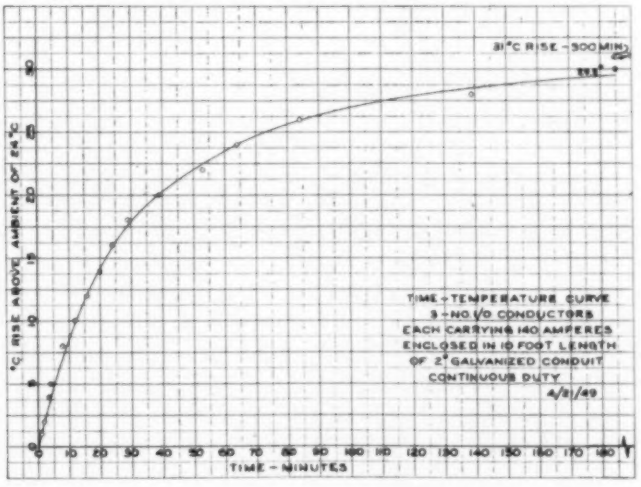
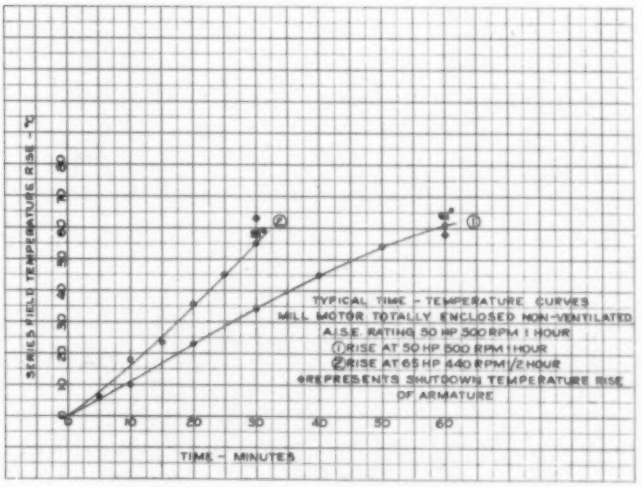


Figure 21 — Typical time-temperature curves for AISE standardized mill motor operating at rated load of 50 hp for one hour and 65 hp for one-half hour.


SERIES FIELD TEMPERATURE RISE - °C
TIME - MINUTES
TYPICAL TIME - TEMPERATURE CURVES
MILL MOTOR TOTALLY ENCLOSED NON-VENTILATED
AISE RATING 50 HP 500 RPM 1 HOUR
① RISE AT 50 HP 500 RPM 1 HOUR
② RISE AT 65 HP 440 RPM 1/2 HOUR
REPRESENTS SHUTDOWN TEMPERATURE RISE OF ARMATURE

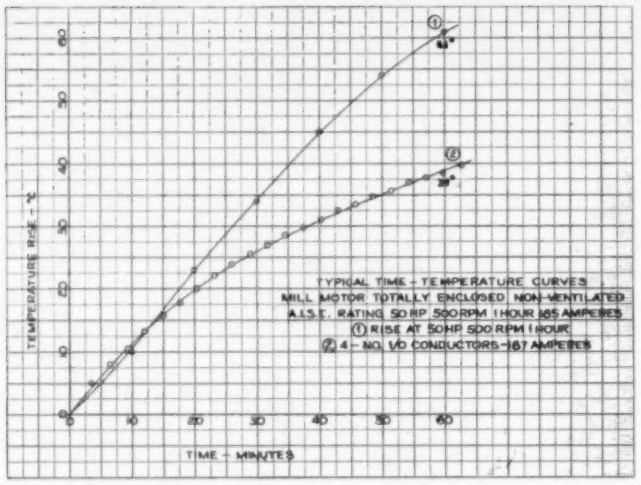
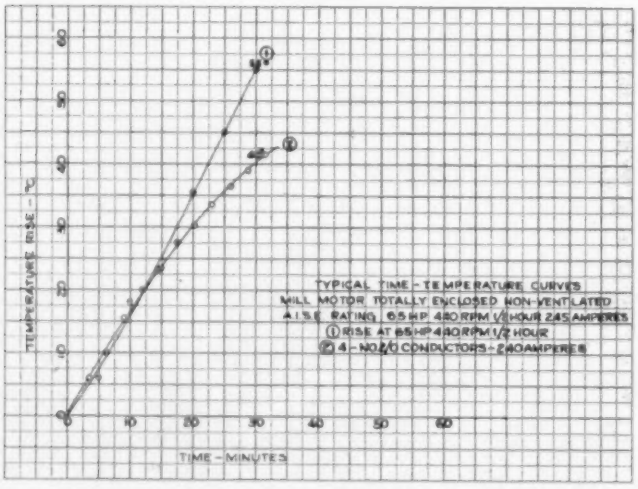

TYPICAL TIME - TEMPERATURE CURVES
MILL MOTOR TOTALLY ENCLOSED NON-VENTILATED
A.I.S.E. RATING 50 HP 500 RPM 1 HOUR 185 AMPERES
① RISE AT 50 HP 500 RPM 1 HOUR
② 4 - NO. 1/0 CONDUCTORS - 187 AMPERES
TEMPERATURE RISE - °C
TIME - MINUTES

Figure 23 — Comparison of time-temperature curves for an AISE standardized mill motor running at 50-hp rated load of 185 amp for one hour and four 1/0 conductors in conduit carrying 187 amp.

30 minute rating has been matched with the temperature rise of four 2/0 conductors carrying 240 amperes. The 2/0 conductors are recommended by the Wiring Committee for the 610 frame for heavy intermittent duty service. The temperature rise of 40 C in 30 minutes gives an operating temperature of 70 C with an ambient of 30 C.

Since the maximum operating temperature of RH type cable is 75 C, it will be noted that the cable performance has been closely matched with the 30 minute and 60 minute motor ratings. It will further be observed that the motor 30 minute rating which is carried by the four 2/0 conductors with an operating temperature of 70 C in 30 minutes would cause four 1/0 conductors to operate at a temperature in excess of the cable rating of 75 C. This means that the one-half hour motor rating is harder for the cable to handle than is the 60 minute rating.

Figure 24 — Comparison of time-temperature curves for an AISE standardized mill motor running at 65-hp rated load of 245 amp and four 2/0 conductors carrying 240 amp.


TYPICAL TIME - TEMPERATURE CURVES
MILL MOTOR TOTALLY ENCLOSED NON-VENTILATED
A.I.S.E. RATING 65 HP 480 RPM ½ HOUR 245 AMPERES
① RISE AT 65 HP 480 RPM ½ HOUR
② 4 - NO 2/0 CONDUCTORS - 240 AMPERES
TEMPERATURE RISE - °C
TIME - MINUTES

Actually, there are few cases where applications require mill type motors to be operated at their 30 minute or 60 minute ratings continuously, are permitted to cool to ambient temperature, and then have the cycle repeated. Usually, the cycles are of much shorter duration and the loads are varying. An intermittent duty cycle is much easier for the cable to handle as illustrated in Figure 10. The 50 per cent duty cycle at 200 amperes shown in this curve compares with a 20 per cent duty cycle for an enclosed type motor of the AISE frame size rated at 65 hp for 30 minutes and 50 hp for 60 minutes.

Based on the foregoing analysis, the Wiring Committee concludes that the conductor sizes shown in AISE Tentative Standard No. 8 are suitable for mill auxiliary duty and heavy duty mill service, as well as for average duty and heavy duty crane service.

It is the committee's recommendation that Tentative Standard No. 8 be used as the tentative standard to determine mill auxiliary drive motor conductor sizes.

Two items in the agenda, item D and item E, cover types of conduits, fittings, insulated bushings, junction boxes and their location, the standardization of meth-

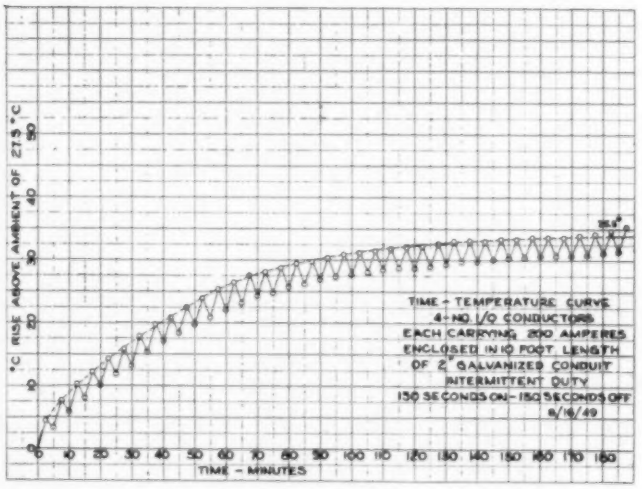

°C RISE ABOVE AMBIENT OF 27.5 °C
TIME - TEMPERATURE CURVE
4 - NO 1/0 CONDUCTORS
EACH CARRYING 200 AMPERES
ENCLOSED IN 10 FOOT LENGTH
OF 2" GALVANIZED CONDUIT
INTERMITTENT DUTY
150 SECONDS ON - 150 SECONDS OFF
6/16/49
TIME - MINUTES

Figure 10 — A 200-amp, 50-per cent time on duty cycle for four 1/0 conductors produces a rise of 35.5 C. This duty cycle exceeds the 50-hp intermittent rating of the AISE enclosed frame mill motor.

ods of wiring, including insulation and segregation in junction boxes, at motors, panels, and resistors, and marking or identification of circuits. These items are being handled by a subcommittee headed by A. L. Schroeder. Quite a little work has been done along this line and they expect to propose a standard soon.

The remaining items on the agenda, F, G, H, and I, have had little work done on them, so we have little to report at this time.

The Wiring Committee welcomes any suggestions about the standards that have been developed, about the items that have been included in the standards, or any items which should be in the standards which are not in them, or reports of experiences with the standards during installation or operation.

DISCUSSION

PRESENTED BY

E. L. ANDERSON, Superintendent Electrical Department, Bethlehem Steel Co., Johnstown, Pa.

B. YAGELLO, Electrical Engineer, Alliance Machine Co., Alliance, Ohio

C. G. DIMITT, Supervisor Design Engineering (Electrical), United States Steel Co., Chicago, Ill.

R. T. HORSFALL, Assistant Chief Engineer, Dingle Clark Co., Cleveland, Ohio

E. L. Anderson: I would like to compliment Mr. Dimitt on the work his committee has done on wiring standardization. I note that one of the subjects to be worked on in the future is the standardization of resistor box dimensions. I suggest that the committee consider the standardization of ohmic value and current carrying capacities along with the standardization of dimensions.

B. Yagello: Relative to Tables II and Alternate Tables II and III, there is shown the tabulation of the half and one hour ratings of the motors. There is also the tabulation of sizes for average and heavy duty wire service. Inasmuch as the continuous ratings are of no interest to crane builders, that section is not considered. With four columns of tabulation, each motor rating, whether half or one hour, will have two wire sizes indicated depending on the service involved.

Are we to assume that when a half hour rated motor is used for average duty service, the half hour motor rating automatically becomes a one hour rating when used for average or heavy duty service? Or is there the implication that when an hour rated motor is used for average or heavy duty service, the same wire size is applicable when the half hour rated motor is used?

C. G. Dimitt: It is assumed that when motors are applied to cranes that the ½ hour rating will generally be used as a reference to avoid confusion. However, when a given frame size is applied to average duty service, the conductors for that frame size will be selected from the average duty column in Table II, in Table III, or in the Alternate Table. When that same frame size is applied to heavy duty service, the conductors will be selected from the heavy duty column.

The tabulation of wire sizes you have referred to appear in the June 1950 issue of the Iron & Steel Engineer in Standard No. 8, as Table IV. These data were included for reference, and would not be required for the frame sizes listed in Tables II, III, and Alternate Table because the cable sizes are there tabulated. However, as a check, assume the use of the AISE 610 frame as being applied to average duty. The 1-hour current rating is 185 amperes. In Table IV, in the 60-minute rating column, the 1/0 cable is rated 190 amperes. This is the size shown in Table II for frame 610, for average duty service. Again, assume the frame 610 as being applied to heavy duty service. The ½-hour current rating is 245 amperes. In Table IV, in the 30-minute rating column, the 2/0 cable is rated 267 amperes. This is the size shown in Table II for frame 610, for heavy duty service.

If the ½-hour current rating of 245 amperes were applied to the 60-minute rating column, the cable size would be 3/0, which is larger than is necessary as indicated by the motor and cable test curves included in the committee's report.

B. Yagello: The question still remains. If we have chosen as the basis one rating of the mill motor, namely the half hour or crane, for average duty, would it be proper to apply the average duty (one hour ratings) of the wire to a half hour rated motor? Though a certain frame size of motor is chosen in the half hour rating for a particular application, not all the horsepower designated by the rating is used. If the motor were wired for heavy duty service, we can only assume the same reserve in the wire as in the motor.

To be specific, we shall apply a 612, 100-hp 1½-hr rated motor on an average duty crane service. Are we to use the one hour ratings of the wire because of the service or are we to use the half hour rating of the wire because of the half hour motor rating.

C. G. Dimitt: Yes, the one hour rating of the cable would be applied because of the average duty service. If the service were to be heavy duty, then the ½-hour rating of the cable would be applied.

B. Yagello: Since the column is for half-hour ratings and applying these ratings to an average duty crane, are we in line in using the one hour ratings of the wire?

C. G. Dimitt: If the crane duty were average, the 1-hr motor current rating would be selected to determine the cable size from the 60-minute column in Table IV. If the crane duty were heavy, the ½-hr motor current rating would be selected to determine the cable size from the 30-minute column in Table IV. However, as pointed out previously, reference to Table IV is not necessary if Table II, Table III or the Alternate Table are used.

R. T. Horsfall: We have had quite a few experiences in applying wire sizes on cranes, car dumpers, ore unloaders and the like. It is plain that we should hold to some standard. We have talked to a number of different steel mill engineers and have heard various ideas about the application of cable. From our experience, we would prefer the horsepower ratings, to answer one of the questions.

There is one thing we would like to question. If we interpret the standard properly, it classifies ore bridges for outdoor, heavy duty and high temperature application requiring Type AVA wire. We have never felt that type of wire was suitable for outdoor application because of the asbestos and varnished cambric insulation and asbestos covering. It has weather impregnation, but we never felt that it gave sufficient protection against moisture. In our opinion, the RH Type wire which has both very good heat resistance and also moisture resistance is better. We have had some recent applications in which the steel mill engineers have preferred the RH wire.

On wire sizes for main feeders, in most cases, we have found the determining factor is not the current carrying capacity but the voltage drop. Of course, you get variable ideas as to what the voltage drop value should be. It has been our practice to use five per cent. In addition to the voltage drop on the main feeders, the

drop on the bridge collector system must be calculated. Either a steel angle or steel rail with a copper booster is used. We have used a cable, and we are now using a copper bar booster.

Of course, the resistance must be determined by assuming a ratio of resistance between the steel and copper in order to calculate the voltage drop. We use a ratio of ten to one. We also have to make an assumption as to the value of current to use in calculating voltage drop.

For example, on an ore bridge we use 70 per cent of the full load current of all motors on the trolley in calculating the voltage drop at the hold, close and trolley motors. The drop to the bridge moving motors is figured with 100 per cent of the bridge motor load only.

We would appreciate your comments regarding these remarks.

C. G. Dimitt: Generally speaking, for an outside application, the committee favors the use of RR type cable.

A number of plants have used cable of the AVA type with moisture resisting impregnation on outdoor applications without difficulty. Other plants have had considerable difficulty. Where voltage drop does not become a factor, the use of AVA conductors permits the use of conductors having less copper than RH conductors, with an equivalent carrying capacity.

I think perhaps the difficulties experienced with AVA cable during service could be attributed to installation practices.

There is one plant in which the main feeders on a number of ore bridges installed in 1941 have used AVA cable for feeders and for motor circuits, and there have been no difficulties whatever.

For one thing, the conduit systems are complete and water is kept out. During installation, care was exercised in handling the cable to prevent damage to covering or insulation. Elbows and junction boxes were provided to give generous bending radii.

Something was said about feeder size standardization. We can appreciate that that is a rather involved project. It is felt that if we cannot standardize on cable sizes, at least we can standardize on the methods of computing the feeder sizes. In each plant and probably in the different departments in each plant, those responsible all have their own methods of selecting cable sizes for a given situation. It is usually based on past experience, the sizes of the cable that are already in service, whether or not they have given satisfactory service or have given trouble. We have felt that we should attempt to set up standards for conductor sizes, depending upon average conditions and length. For conditions where such standards could not be used, we would develop a standard method of computing conductor sizes.

R. T. Horsfall: I was wondering whether the committee had discussed the possibility of open installation, in particular on the main risers, of an ore bridge as compared to wiring in conduits. There is a terrific difference in the size of wire and the cost of installation. We have had several requests for the open installation and other engineers prefer to have it completely concealed. Has there been any discussion on that point?

C. G. Dimitt: Recently there has been little discussion about it. A number of years ago, open construction was used not only for the feeders but for the wiring of motors, resistors, etc. In later years, it has been felt that the cable should be protected from the weather and from mechanical injuries. All the recent installations of ore bridges with which we are familiar have used complete conduit systems.

Of course there are some circuits such as the main power, motor, and control circuits between the bridge structure and pivoting piers which require flexible connections. For these connections, a cable, similar to a welding cable in flexibility, with a heavy rubber sheath, has been used successfully. Aside from these flexible connections, we do not believe there has been a general tendency to use open wiring.

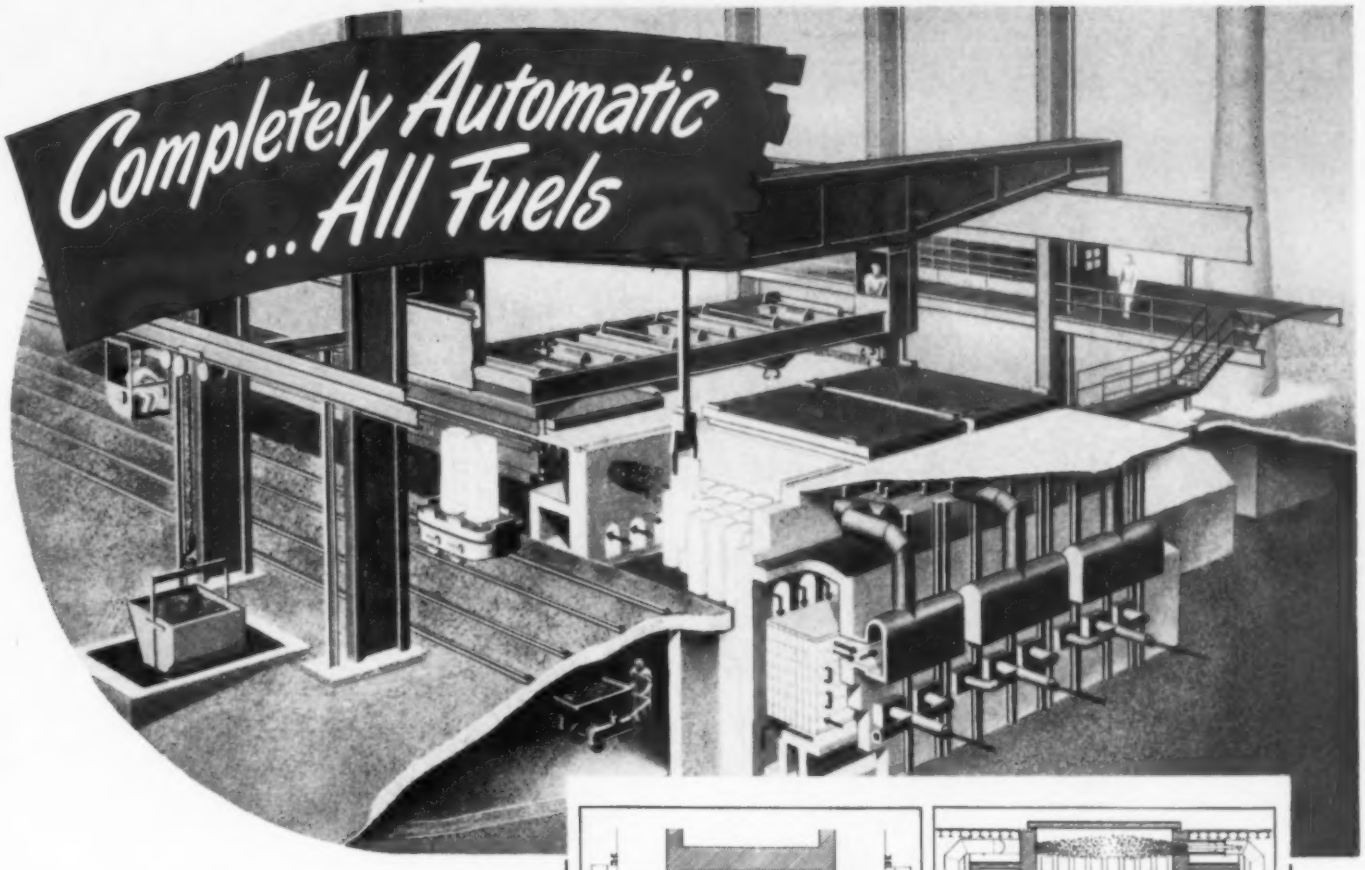
This is something that may change with various conditions that have to be met on a specific installation, and may be affected to some extent by code restrictions in some districts. Some plants are in city areas where codes are applied rather rigidly.

A LOOK AT SWEDEN'S IRON AND STEEL INDUSTRY*

▲ DURING the summer of 1950, the writer had an opportunity to visit the larger iron-ore mines and a number of steel plants in Sweden as a guest of Jernkontoret, an association of Swedish iron and steel producers. Time did not permit a detailed study of the practice at any one plant but it was possible to obtain a general perspective of an old and efficiently managed industry developed to meet the conditions peculiar to the country. It will be the purpose of this short paper to give an overall view of Sweden's iron and steel industry with emphasis on a few characteristic features.

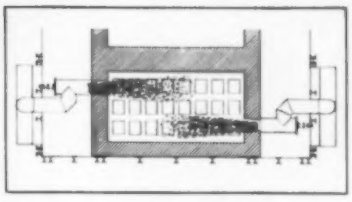
Large reserves of dense magnetite, cheap electric power, the lack of domestic coking coal, and the availability of charcoal have been dominant factors in shaping Sweden's iron and steel industry. In order to minimize the consumption of domestic charcoal and imported coke, both expensive, outstanding progress has been made in the preparation of burdens high in iron, low in silica, and easily reduced. Charcoal pig iron, used exclusively for the production of quality steel and quality grey-iron castings, is still made in substantial tonnages. The capacity of individual furnaces is relatively small, with emphasis on close control of the operation rather than on tonnage. Several small blast furnaces, for example, are generally preferred to a single large unit of equivalent capacity because the smaller units operate efficiently on self-fluxing sinter and produce iron of uniform analysis.

* Brief abstract from paper of same title presented by T. L. Joseph, Professor of Metallurgy, University of Minnesota, at annual conference of the Blast Furnace, Coke Oven and Raw Material Committee of the AIMME, Cleveland, Ohio, April 3, 1951.

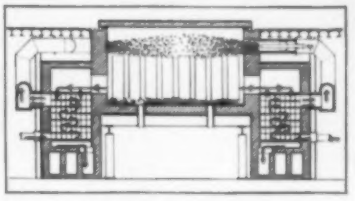


RUST
Continuous Fired
SOAKING PITS

- Two-way Fired
- Recuperative Type
- Fully Automatic
- Choice of Fuels



PLAN VIEW



CROSS SECTION

Thanks to superior design, Rust Soaking Pits have greater charging capacity per square foot of area. Sketches above indicate the diagonal two-way firing, by which heat is distributed uniformly throughout the pit; on cut backs both ends of pit remain in balance, thus ingots soak out evenly. absence of impingement increases life of refractory walls and covers.

Design permits construction in batteries of two or more holes. With 45 years of experience as a background, Rust engineering from start to finish guarantees the utmost in efficiency and economy.

For Either a New or Modernization Job, Consult Rust Now!

THE WHOLE JOB IS ONE JOB WITH A

RUST "PACKAGE" CONTRACT

ONE RUST CONTRACT covers everything . . . from blueprint to test-run. Rust assumes responsibility for design, manufacture and erection of all essential material . . . including excavations, foundations, wiring and piping. Your purchasing and engineering departments are freed of subcontractor headaches when you order from Rust.

F-3

RUST FURNACE CO.

PITTSBURGH, PENNSYLVANIA

AISE SPRING CONFERENCE - DETROIT, MICH.

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The annual spring conference, sponsored by the rolling mill committee of the Association of Iron and Steel Engineers was held at the Hotel Statler, Detroit, Mich., Monday and Tuesday, April 30 and May 1, 1951. Nearly a thousand operating and engineering executives in the steel industry were in attendance. Registration (1) was held on the ballroom floor. O. P. Ashurst (right in 2), secretary, AISE Detroit district section, supervised arrangements which made this spring conference one of the most successful ever held by the AISE. During the meeting, George P. Lauder, of the Detroit Convention and Tourists' Bureau, presented a special memento in honor of the 250th anniversary of the founding of Detroit to John F. Black, AISE president, and T. J. Ess, AISE managing director (3).

Fifteen technical papers were presented in six sessions during the two day conference. Some of the participants in Monday's technical sessions were: (4) J. N. Imel, F. H. Rowe, and W. L. Keene; (5) H. S. Avery, C. E. S. Eddie, Ward Holland, and J. J. Healy; (6) Edgar Herold, L. C. Sowell, C. P. Hammond, Wade Hoffman, and W. H. Mohler; (7) A. J. F. MacQueen, A. W. McAuly, F. C. Fennell, H. E. Larson, and H. H. Angel.

On Monday evening, the spring conference dinner was held in the ballroom at the Hotel Statler. Richard E. Roberts, manager of employees relations department, Ford Motor Co., was the speaker. Shown in (8) are John L. Young, U. S. Steel Co., Mr. Roberts, and J. A. Clauss, Great Lakes Steel Corp. The host for the inspection trip on Tuesday was J. K. Sutherland, manager of steel operations, Ford Motor Co., shown (center in 9) with F. E. Flynn, Republic Steel Corp., (left) and J. A. Vohr, U. S. Steel Co., (right).

Some of the authors and chairmen in Tuesday's technical session were: (10) A. Krause, D. W. Lloyd, and J. R. Chegwidden; and (11) R. R. Shedd, F. H. Graham, J. E. Hovis, A. F. Kritscher, and E. T. W. Bailey.

Seen around the conference were: (12) L. H. Loufek, W. R. Harris, and G. M. Hunter; (13) D. W. Lloyd, J. L. Campbell, William Pope, and W. J. Reilly; (14) R. H. Scholl, B. A. LeMonte, A. K. Best, F. H. Dyke, and H. W. Evans; (15) A. B. Frost, S. A. Swetonic, and J. M. Lewis; (16) C. S. Lambert, R. E. Willis, and E. D. Mesta; (17) A. R. Frame, L. D. Smith, and A. A. McElwain.

Tuesday afternoon an inspection trip (18) was conducted through the automobile assembly line and the steel plant of the Ford Motor Co. at Dearborn, Mich.

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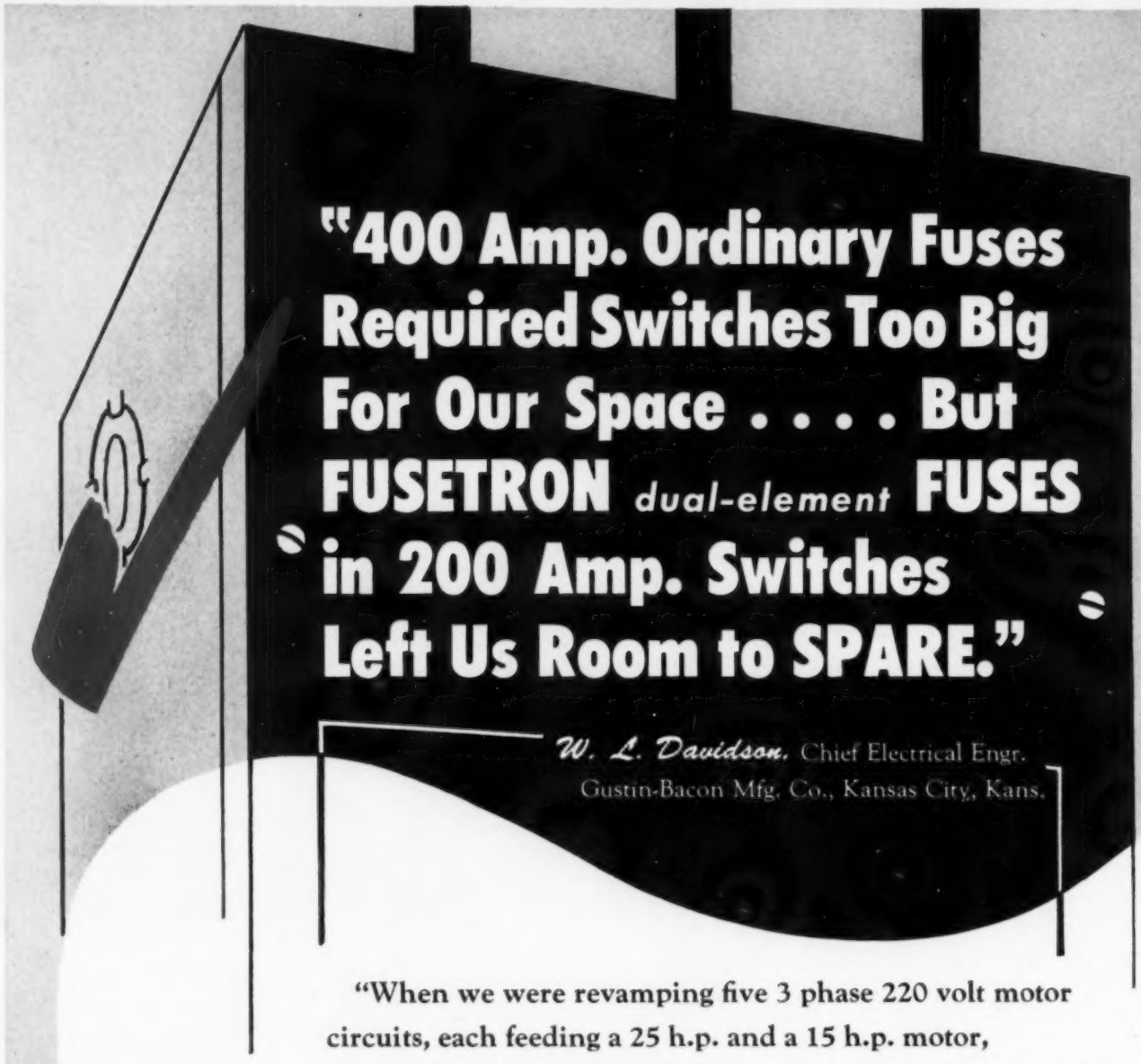

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Gustin-Bacon Mfg. Co., Kansas City, Kans.

"When we were revamping five 3 phase 220 volt motor circuits, each feeding a 25 h.p. and a 15 h.p. motor, at our Fairfax plant — we found we were short of room for the 400 amp. main switches required by ordinary fuses.

"By changing to Fusetron dual-element fuses, however, we were able to use 200 amp. switches and have room to spare.

"The installation has proved very satisfactory, and in addition, we get better protection because the motors are fused nearer to the operating load."

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TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
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(FUSETRON is a trade mark of the Bussmann Mfg. Co., Division of McGraw Electric Co.)

You Get 10 Point Protection by changing to

Fusetron DUAL-ELEMENT Fuses

1* Protect against short-circuits.

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

★Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York City in December 1947.

Here's Why You Get This All-Purpose Protection

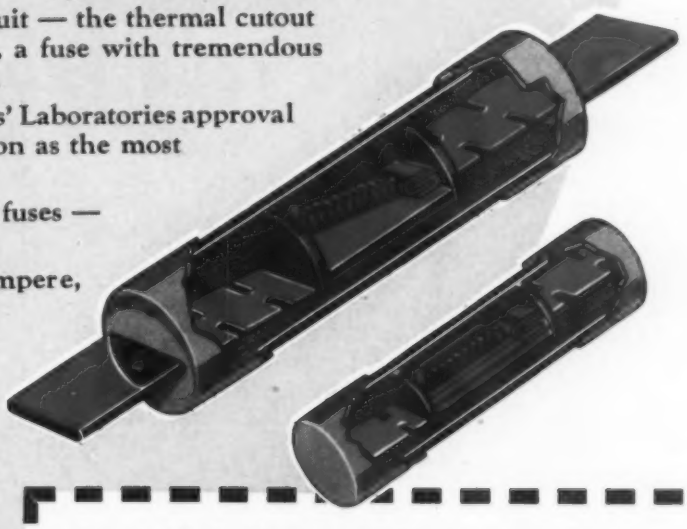
The fuse link element opens on short-circuit — the thermal cutout element protects on overloads — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses — fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.



Don't Risk Losses!

One **needless** shutdown . . .
One **lost** motor . . .
One **destroyed** switch or panel . . .
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

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Date-line Diary...

April 2, 1951

▲ Republic Steel Corp. reports that steelmaking capacity in 1950 increased 267,000 tons. Record earnings totaled $63,794,711 for 1950. A $75,000,000 expansion program is on in Cleveland which will add 672,000 tons to capacity, and additional expansion and development of new ore sources in Labrador and Liberia will result in an additional expenditure of $150,000,000.

▲ Based on reports of companies having 93 per cent capacity of the steel industry, the operating rate is scheduled at 102.4 per cent of capacity for the week beginning April 2, 1951. This is equivalent to 2,047,000 tons of steel ingots and castings compared with 2,069,000 tons one week ago.

April 3

▲ Lone Star Steel Co. stockholders voted to increase the company's capital stock by 640,000 shares. A government loan of $73,425,201 will be used to expand present facilities into an integrated steel mill at the East Texas Work site, which is expected to produce 500,000 tons of steel ingots annually.

▲ Following a meeting of the company's board of directors, Granite City Steel Co. is offering 284,114 shares of common stock at $22 1/8 a share on the basis of 1 share for each 3 1/2 shares held.

▲ Companies in the iron and steel industry will spend $1,200,000,000 on plant expansion in 1951 according to the AISI. A new high of 25,400,000 tons of steel was produced in the first three months of 1951. Steel output is expected to rise 5,000,000 tons over last year's record 96,696,769 tons.

April 4

▲ United States Steel Co. has awarded a contract for an 80-in. continuous hot strip mill to Mesta Machine Co. to serve the Fairless Works at Morrisville, Pa.

April 5

▲ Defense Mobilizer Wilson stated that by the end of the calendar year, 15 per cent of national production will be for defense.

▲ Steel mills have been ordered by the NPA to reserve for defense needs 10 to 63 per cent of their June production of carbon steel products.

▲ A $2,000,000 continuous sheet galvanizing line is contemplated by Wheeling Steel Corp. Rebuilding and modernizing bessemer facilities, which would increase capacity by 150,000 tons per year, is also planned at an estimated cost of $7,000,000. A $40,000,000 improvement and modernization program has just been completed by the company.

April 6

▲ ARCI and AAR announced freight car deliveries in March totaled 7,011 an increase over 5,842 cars delivered in February. Backlog of cars on order rose to 158,619 on April 1.

April 7

▲ The NPA assumed complete control over production of many alloys which include nickel steel.

April 9

▲ An estimated expenditure of $7,000,000,000 in the electric power industry is expected in the next three years. This industry expects to install 24,000,000 kw within that time.

▲ The Office of Price Stabilization is expected to set specific price ceilings for stainless steel scrap.

▲ Based on reports from companies having 93 per cent capacity of the steel industry, the operating rate for the week beginning April 9 is scheduled at 102.3 per cent. This is equivalent to 2,045,000 tons of steel ingots and castings compared with 2,047,000 one week ago.

April 10

▲ The Aluminum Association reports that sheet and plate shipped by members of the sheet division totaled 94,735,970 lb in February compared with 112,070,040 lb in January. This decrease was due to fewer number of days in February.

▲ Because business volume has declined, New York Central Railroad announced that it was laying off several thousand employees in 11 eastern states.

▲ The Council of Economic Advisers announced that total production of all goods and services rose to an annual rate of $316,000,000,000 in the first quarter of 1951.

▲ AISI reports a record of 25,658,868 tons of steel ingots and castings were produced in the first quarter of 1951. Steel production exceeded 9,000,000 tons a month for the first time. The furnaces were operated at an average capacity of 102.2 per cent in March.

April 11

▲ U. S. exports totaled $1,073,000,000 in February, up $101,000,000 from January, however, imports were $907,000,000, off $114,000,000 from the record January level.

April 12

▲ DTA chief, James K. Knudson, estimates railroads this year will be called upon to haul about 687,000,000,000 ton-miles of freight. Mr. Knudson recommended that 300,000 new freight cars be built to handle this increase.

▲ On April 3, Gibraltar Steel Corp. allowed their option to expire on the site of a proposed $100,000,000 steel plant.

April 13

▲ The Defense Minerals Administration has $10,000,000 availabie for the remaining fiscal year from which to contribute from 50 to 90 per cent of the cost of searching for and mining vitally needed minerals.

▲ The Government announced that its "Controlled Materials Plan" will go into effect July 1. Specific quantities of steel, aluminum and copper will be doled out by the NPA for defense and essential civilian purposes.

▲ All rail shipments of iron ore from its mines to eastern steel mills will continue this spring and summer, by the Oliver Iron Mining Co.

April 16

▲ Crucible Steel Co. of America has begun work on its estimated $27,250,000 expansion program. The construction of a new blast furnace at Midland will increase pig iron capacity.

▲ F. W. Dodge Corp. reports that construction awards in the 37 states east of the Rockies totaled $1,267,450,000. Mr. Thomas S. Holden, president of the company, stated "The expected squeeze in construction has started."

▲ Based on reports from companies having 93 per cent of the capacity of the steel industry, the operating rate is scheduled to be 102.9 per cent of capacity for the week beginning April 16. This is equivalent to 2,057,000 tons of steel ingots and castings compared with 2,045,000 tons one week ago.

April 18

▲ A par value of $25.00 on common stock was

approved by the stockholders of Crucible Steel Co.

▲ An expansion program is planned by General Electric Co. in the next four years on which it will spend $350,000,000.

▲ Reconstruction Finance Corp. reduced tin 5 cents a lb to $1.42 for commercial users.

▲ Defense Production Administration announced steel allocations of 1,400,000 tons to 24 defense and essential civilian programs.

▲ Compulsory government rationing of nickel will begin on May 1, Defense Production Department's metal administrator F. V. C. Hewell of Canada stated.

April 19

▲ Acme Steel Co.'s net sales of $21,663,216 for the first quarter of 1951 have risen 34.9 per cent over the same period last year.

▲ Westinghouse Electric Corp.'s first quarter net profits rose to $1.05 per common share on net sales of $290,407,895. New orders in the first quarter set a new record and were double those for the first quarter of 1950.

April 20

▲ Armco Steel Corp. announced net earnings of $10,443,239 for the first quarter of 1951, which is equal to $2.09 per common share after preferred dividend allowance.

April 21

▲ Due to increased living costs, General Electric Co. workers will get a 9¢ an hr wage increase.

▲ Because of the continued demand for steel, iron ore use increased, and 7,371,888 tons were consumed in March.

April 23

▲ Allegheny Ludlum Steel Corp. announced first quarter earnings of $3,303,691 or $2.03 per share of common stock.

▲ Based on reports from companies having 93 per cent capacity for the steel industry, the operating rate is scheduled at 103.3 per cent of capacity for the week beginning April 23, 1951. This is equivalent to 2,065,000 tons of steel ingots and castings compared to 2,057,000 tons one week ago.

April 24

▲ An extensive expansion program has begun for the Youngstown Sheet & Tube Co. in the Chicago District plants at an estimated cost of $100,000,000, which will provide facilities for approximately 1,000,000 additional tons of ingots.

▲ For the first quarter of 1951, United States Steel Co. reported earnings of $48,663,781, and declared a quarterly dividend of $1.75 per share on preferred stock and 75 cents per share on common stock. Shipments of steel products for this period amounted to 6,070,892 net tons. Expenditures, as of March 31, 1951, for authorized projects to be completed requires an expenditure of $691,000,000, which includes estimated cost of the new Fairless Works at Morrisville, Pa.

▲ The merger between Pittsburgh Steel Co. and Allegheny Ludlum Steel Corp. is off, and each company will continue individual expansion programs.

▲ AISC reports March bookings of fabricated structural steel totaled 230,409 tons. Shipments for March totaled 194,774 tons an increase of 16.7 per cent over February. The backlog for the next four months amounts to 798,356 tons.

April 25

▲ The International Nickel Co. of Canada, Ltd. reported 1950 net profit of $48,765,849, which was equivalent to $3.21 per share on common stock. A new record for peace-time deliveries of nickel in all forms totaled 256,410,543 lb. By 1953 the company expects to be hoisting 13,000,000 tons of underground ore annually which is about double that in the past. To date $100,000,000 has been spent on development of production facilities, and $30,000,000 more has been authorized to be spent. Ore reserves at the end of the year amounted to 252,859,725 short tons.

▲ Jones & Laughlin Steel Corp. announced net income for the first quarter of 1951 of $8,255,000, compared with $5,310,000 for the same quarter in 1950, and declared dividend of $1.27 per share of common stock.

▲ Inland Steel Co. announced net income of $9,318,270 for the first quarter of 1951, or $1.90 a share on capital stock. It is predicted that by June, half of the company's total steel production will be set aside for government directed programs.

▲ Price Stabilizer DiSalle announced price regulations for manufacturing concerns which takes effect May 28. Factories are to base new ceilings on the highest prices they charged between April 1 and June 24, 1950, or may choose instead any of the three preceding calendar quarters.

▲ Kaiser Steel Corp. reported net sales for the first nine months of the fiscal year at $6,189,720 or $1.63 a share after preferred stock dividends. Total sales were $72,443,541.

April 26

▲ Alcoa will build a new aluminum smelting plant with an annual capacity of 170,000,000 lb of aluminum at Wenatchee, Wash.

April 27

▲ Bethlehem Steel Co. reported peacetime record sales for the first quarter of 1951 of $426,000,000. Because of increased taxes, net profits dropped to $2.45 a share compared with $2.50 one year ago.

▲ Pittsburgh Steel Co. awarded United Engineering and Foundry Co. contract for a 66-in. continuous hot strip sheet mill for the Allenport, Pa. works.

April 28

▲ Ward's Automotive Reports state that automobile production for the first half of 1951 should exceed 3,000,000 units. This compares with the record 3,106,000 units produced for the same period in 1950.

April 30

▲ DiSalle sets price ceilings on beef.

▲ United Labor Policy Committee, acting as spokesman for union workers, voted for the immediate return of labor officials to defense agencies.

▲ Bethlehem Steel's Lackawanna plant will be the site of a $100,000,000 expansion program which will give an annual capacity of 5,000,000 tons.

▲ National Steel Corp. reports net earnings for the first quarter in 1951 of $13,255,401, or $1.80 a share, compared with $13,434,454 for the first quarter of 1950.

▲ The operating rate of the steel industry for the week beginning April 30th is scheduled at 104.0 per cent of capacity. This is equivalent to 2,079,000 tons compared with 2,065,000 one week ago, and is the largest amount ever scheduled for one week.

▲ The Armco Steel Corp. announced that all outstanding 4½ per cent cumulative convertible preferred stock has been recalled for redemption June 14, 1951 at a price of $103 per share plus accrued dividends. Shares may be converted into common stock at a rate of 2.55 shares of common for one of preferred.

▲ Granite City Steel Co. reports sales for the first quarter of $20,807,409 and net income of $4,431,385 or $1.44 a share.

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In metal cutting, shearing, or trimming operations you can keep costs 'way down . . . and production up . . . by standardizing on Heppenstall Knives!

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1. Remove the cover and the end plate studs.
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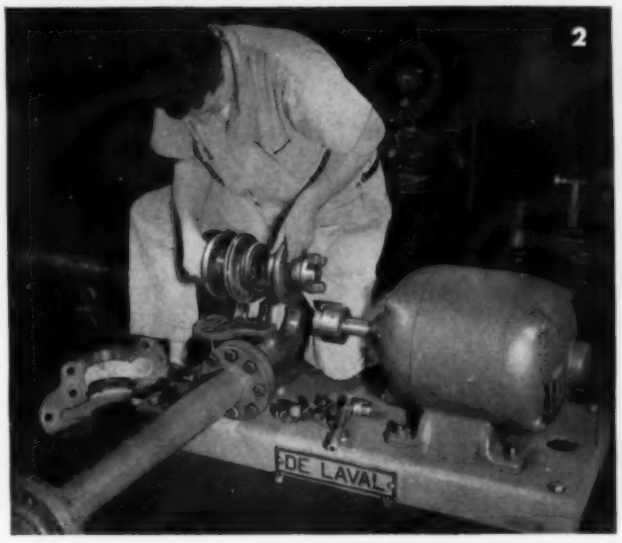
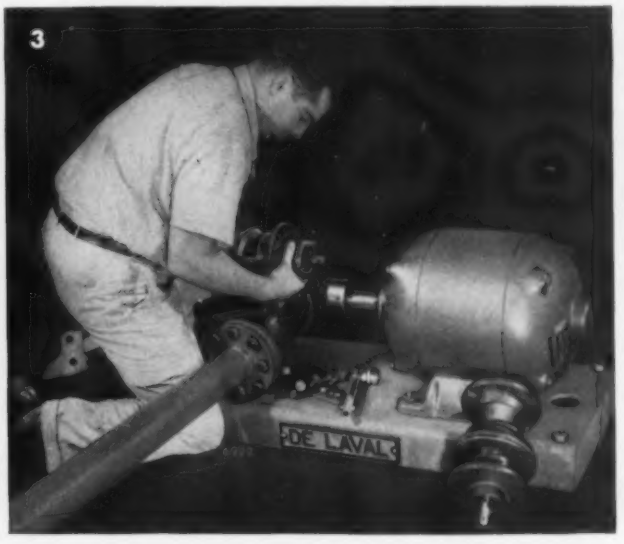
3. Drop a new one in place and return the old one for credit on serviceable parts.





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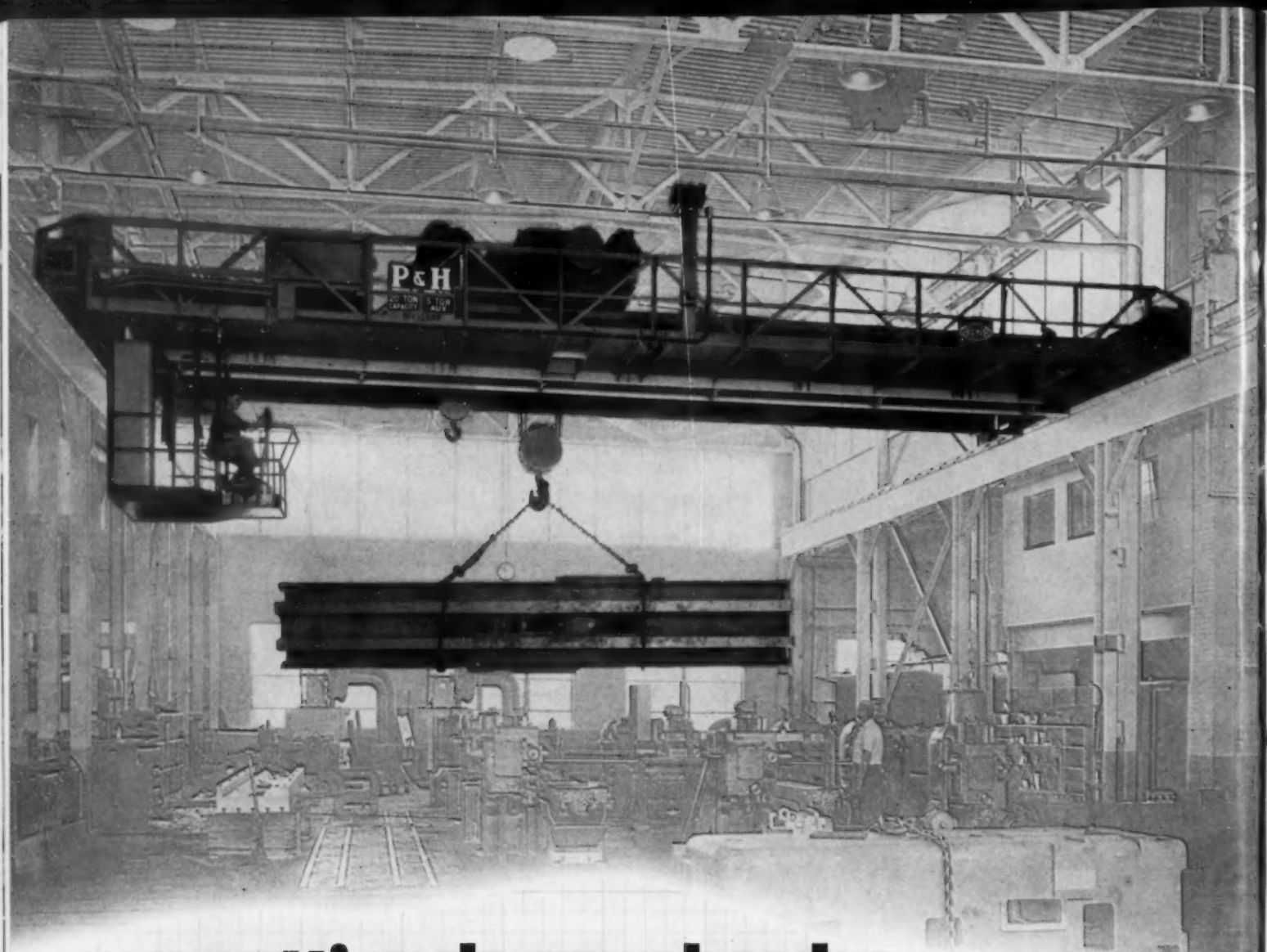

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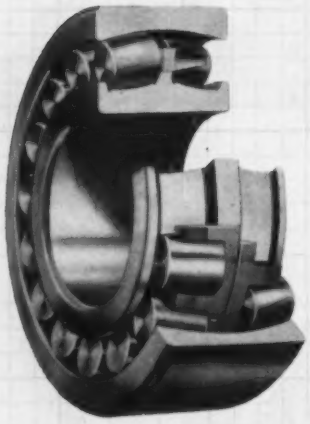

Harnischfeger Corporation uses Torrington Spherical Roller Bearings for the trolley drive of P & H overhead cranes to assure smooth and dependable operation.

Spherical Roller Bearings automatically compensate for shaft deflection and frame distortion so that binding stresses are avoided. These precision bearings require a minimum of maintenance attention.

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Industry News...

RECORD ORE HAUL NEEDED TO SUPPLY 1951 FURNACE DEMAND

▲ More ore than ever before will be needed to feed the hungry blast furnaces if the steel industry is to maintain operation at rates scheduled for 1951. At present, most of the ore used comes from the upper lakes region, and iron ore constitutes the largest tonnage of any material moved on the Great Lakes. Moving the tremendous tonnages needed by the steel mills requires an amazing job of teamwork by the mining, lake carrier, unloading dock and other transportation facilities serving U. S. Steel.

The weather is an important factor in obtaining sufficient ore since a short shipping season may result in shortages because the industry may be unable to stockpile enough ore to carry through the winter season.

U. S. Steel's Pittsburgh Steamship Co. operates 61 ore-carrying ships to bring iron ore down to ports on Lake Erie and on lower Lake Michigan. Fifty-two of these vessels are rated Class A, each having capacity in excess of 10,000 tons. The others are medium-sized Class C ships.

The greatest part of the ore for the corporation's Pittsburgh district mills is shipped principally from the Duluth and the Two Harbors (Minn.) docks on Lake Superior, approximately 900 water miles from the unloading docks at Conneaut, Ohio, to which most of Pittsburgh's ore is shipped.

The average time for the round trip from Duluth to Conneaut is seven days including loading and unloading time and some boats make it in 5½ days.

The harbor at Conneaut is one of the most modern on Lake Erie, having a large outer or entrance harbor, well protected by heavy government-built breakwaters or jetties, and an inner or active harbor extending more than half a mile inland from the lake shore. The inner harbor has a varying width from 200 feet at the entrance to 673 ft at the widest point of the turning basin.

Both sides of the harbor are flanked by heavy modern docks of concrete and steel construction, built to carry safely the heaviest iron ore or coal handling machinery, or any other machinery that may be needed for moving material out of or into lake vessels.

The docks at Conneaut Harbor are operated by a U. S. Steel subsidiary, the Pittsburgh & Conneaut Dock Co., which has been a leader in developing new facilities and methods for handling ore and coal cargoes.

The principal activities of Conneaut Harbor are the unloading of ore from lake vessels into railroad cars for shipment to U. S. Steel and other steel plants or onto dock stockpiles for winter shipment by railroad to these plants, and loading coal from Western Pennsylvania mines and steel products from district mills for shipment to other ports on the Great Lakes and on the St. Lawrence River.

The Conneaut ore handling equipment consists of five Hulett electric ore unloaders and an ore stocking bridge. Each unloader has a 17-ton grab bucket which descends into the hold of the ship, brings out a load of ore, lifts it back over the dock and empties it into a receiving hopper on the frame structure of the machine. The ore is then discharged into a weighing or scale hopper on a larry car. The larry car travels to a point above an empty railroad car, the bottom of the hopper opens and the ore, accurately weighed, is dumped into the car. No further weighing of railroad cars is needed before they are made up into a train.

Ore destined for the stockpile alongside the docks is dumped from the hopper into a trough from which a trolley on the ore stocking bridge transfers it to the storage yard.

The five Hulett unloaders have an average hourly capacity of 3750 tons of ore, 750 tons per machine. Time consumed for unloading the big new vessels of the lake fleet, such as the

On left, the Benjamin F. Fairless arrived at Conneaut, Ohio for the first time during the 1951 season on the afternoon of April 26. The carrier had already made two trips this year to the Chicago District. On right, ore is taken by the Hulett unloaders directly from the Benjamin F. Fairless and loaded directly into cars ready for shipment to the Pittsburgh and Youngstown districts.

The improvement program being carried out by the Bessemer & Lake Erie Railroad on its equipment and roadbed enables fast, economical shipment of ore to the Pittsburgh and Youngstown district plants.

Benjamin F. Fairless, is about three and one-half hours.

Compared with lower lakes' receiving ports, Conneaut ore tonnage exceeds all except the ports of Cleveland and Ashtabula, where total tonnage unloaded by several different docks has some years exceeded the Conneaut total.

The largest cargo of ore to be delivered to Conneaut Harbor arrived August 7, 1947, when the Steamer Fairless docked with 18,725 gross tons in her hold. The only cargo to be delivered to any port on the Great Lakes greater than the Fairless' cargo was carried by the Steamer Sykes when she docked at Indiana Harbor on May 6, 1951 with 19,233 gross tons.

In 1942, Pittsburgh Steamship Co. was responsible for the movement of 36,265,822 gross tons of ore down the lakes for U. S. Steel subsidiary plants and for the blast furnaces of other steel companies. The first ore was unloaded at Conneaut on April 3 and the last vessel to unload arrived December 12.

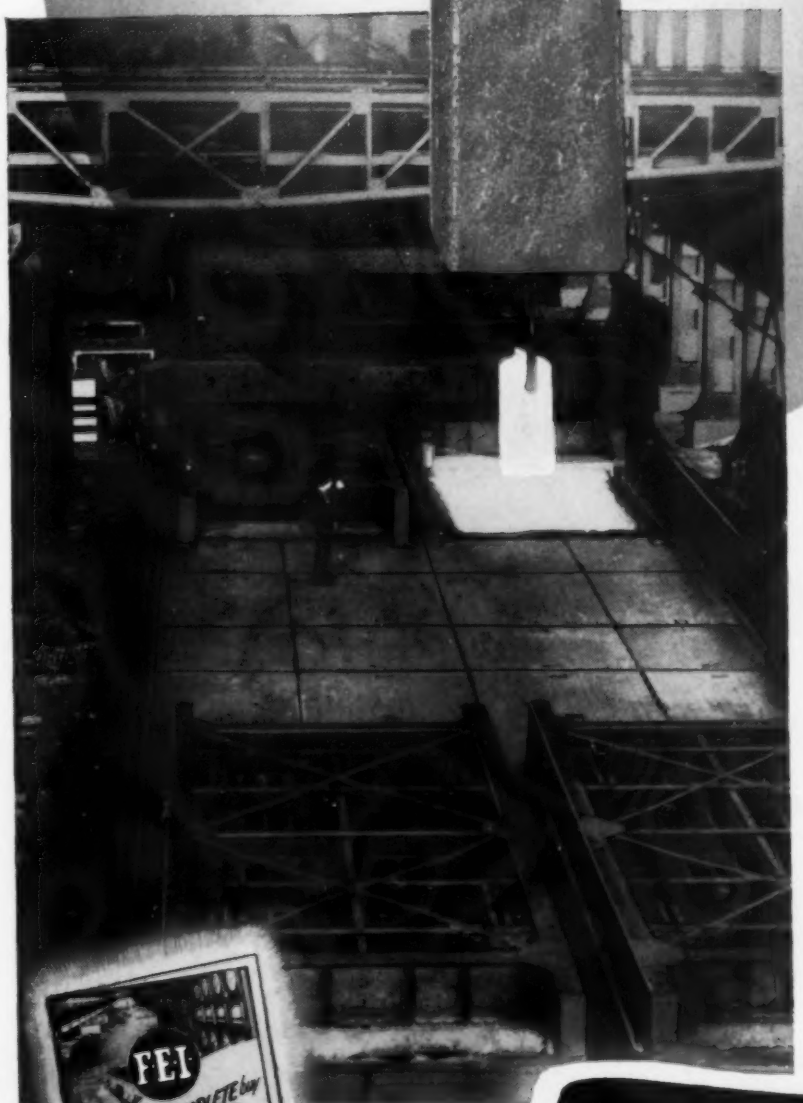
Pittsburgh Steamship Co. expects to be responsible for the movement of 32,500,000 gross tons of ore before the 1951 season closes. This year the first vessel arrived at Conneaut on April 14.

From Conneaut, iron ore is shipped by rail to the blast furnaces over Bessemer and Lake Erie Railroad, a Class I common carrier serving more than 900 shippers and receivers of carload freight along its line. The typical ore train consists of 125 cars. The movement time for an ore car over the 141-mile route between Conneaut and Pittsburgh is less than 10 hours.

Total ore hauled during 1950 was 9,412,879 net tons. In addition to the ore, 5,732,128 tons of coal were moved, much of it to be loaded aboard ship

The Complete Buy **F·E·I** *for Greatly Improved*

INGOT HEATING



regenerative and

one-way recuperative

soaking pits

- **Completely Automatic**
- **High Air-Preheat**
- **Minimum Scaling**

MODERN TO THE Nth DEGREE . . . Latest records show greatly increased output of ingots with minimum fuel consumption.

FIRED BY COLD BLAST FURNACE GAS or any other fuel. F.E.I. Soaking Pits provide extremely high preheated air temperatures.

UNIFORM HEATING, controlled automatically. No impingement. No overscaling. No washing. Minimum maintenance . . . Bottom making practically eliminated. This is due to extremely accurate control of temperature and atmosphere.

Get the facts about F.E.I.—
the complete buy—from original
planning through to actual production.

F-4

Write for This Bulletin covering all types of F.E.I. Heat Treating Furnaces.

Furnace Engineers, Inc.

F.E.I. Building • 1551 West Liberty Avenue • Pittsburgh 16, Pa.

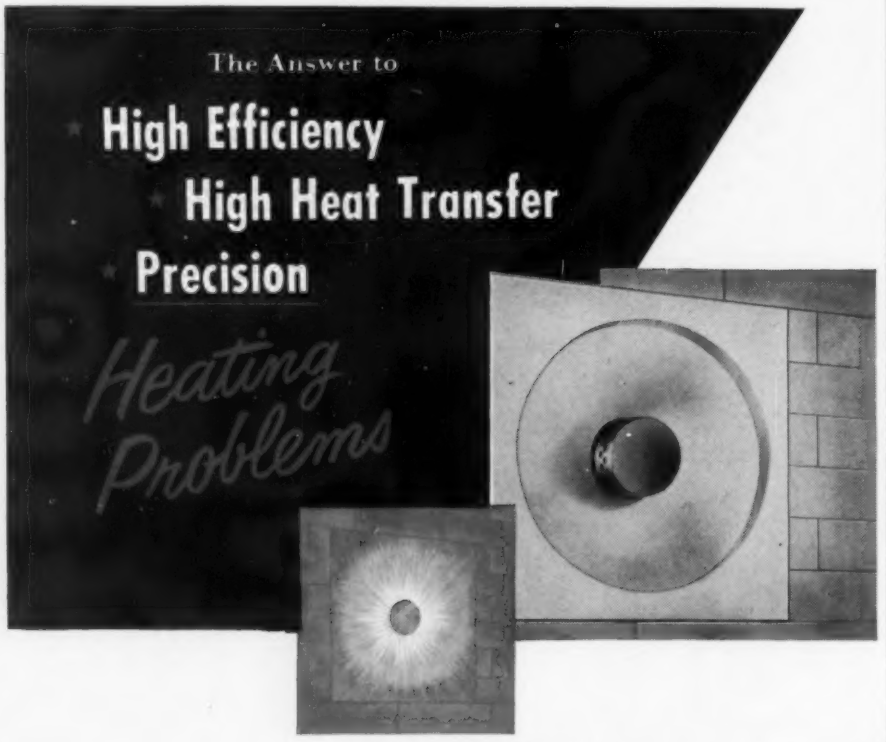
for delivery to other U. S. and Canadian lake ports, and 4,778,689 tons of other freight, most of it steel products. The total tonnage handled was 19,923,696 tons.

The all-time record was 13,957,946 net tons of ore, or 166,455 carloads, moved during 1942. The estimated total for 1951 is 13,500,000 net tons. In addition, during 1942, 6,965,307 tons of coal were hauled, and other freight totaled 6,499,951 for a grand total of 27,423,204 tons, an all-time high.

The all-time record for one month's transportation of ore was achieved in July, 1944, when 1,912,335 tons were hauled.

Limestone for the steel mills also is transported over the Bessemer and Lake Erie in large quantities from the Annandale, Kaylor and Buffalo Creek mines of Michigan Limestone & Chemical Co.

In spite of the record ore expected to be shipped in 1951, by means of the Great Lakes and Bessemer and Lake Erie route, the U. S. Steel Co. expects that it will still be necessary to move ore by an all-rail route from the upper lakes port during the winter season.

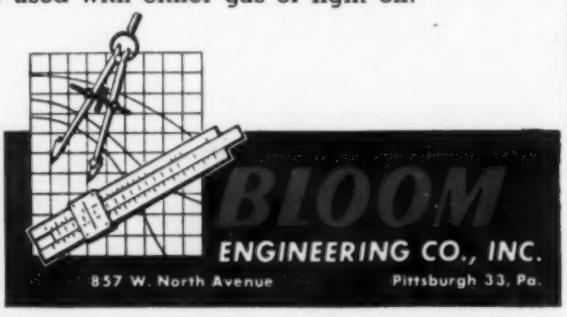


The BLOOM HTR BURNER

High Thermal Release

A unique precision burner for specialized high speed heating applications, the Bloom HTR Burner is ideal for use where fast heating and intense concentration of heat are needed. It will release up to 750,000 Btu per cubic foot of combustion volume. Turndown ratio of greater than 10 to 1 permits low input for holding purposes. Can be used with either gas or light oil.

WRITE for bulletin giving full details and description of this remarkable burner.



FIRM LEASES BUILDING FOR PICKLING PLANT

▲ American Tool and Supply Co. announced that it is installing a semi-continuous steel pickling and processing line in the former Pressed Steel Car Co. plant in McKees Rocks, Pa., near Pittsburgh. Operations are scheduled to begin about June 15. Work will be done on a job basis. A subsidiary, Marsam Corp., will operate the plant.

The pickling line will handle coils up to 48-in. wide, weighing 10,000 lb, and plates and sheets up to 60-in. × 144-in. Shearing, slitting, roller leveling and all other warehouse services will be available. The company has leased 70,000 sq ft for the operation.

Youngstown Welding & Engineering Co. is installing the pickling facilities. McKay Machine Co., Youngstown, is providing the processing equipment.

BEGIN FOUNDATION WORK FOR LONE STAR STEEL

▲ With other large steel firms moving into the Texas iron ore fields, Lone Star Steel Co. has called for full speed ahead in its drive to complete construction of a completely integrated steel mill costing $73,425,201. For the past several weeks, engineers have been preparing the necessary markers to guide workmen in the initial grading and leveling stages at the site 30 miles north of Longview.

Structural steel for the buildings will arrive around August 1, and to keep up with the construction schedule, foundations must be ready then. The setting of foundations would require more time than usual because of the tremendous weights they will carry.

WEIRTON ANNOUNCES 1951 VACATION PLANS

▲ Over 1700 salaried employees of the Weirton Steel Co. will receive vacation pay ranging from one to three weeks, depending upon length of service. Vacation pay will be in-

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*Comparison with Type RH based on Chapter X—National Electrical Code, 40°C-104°F Ambient

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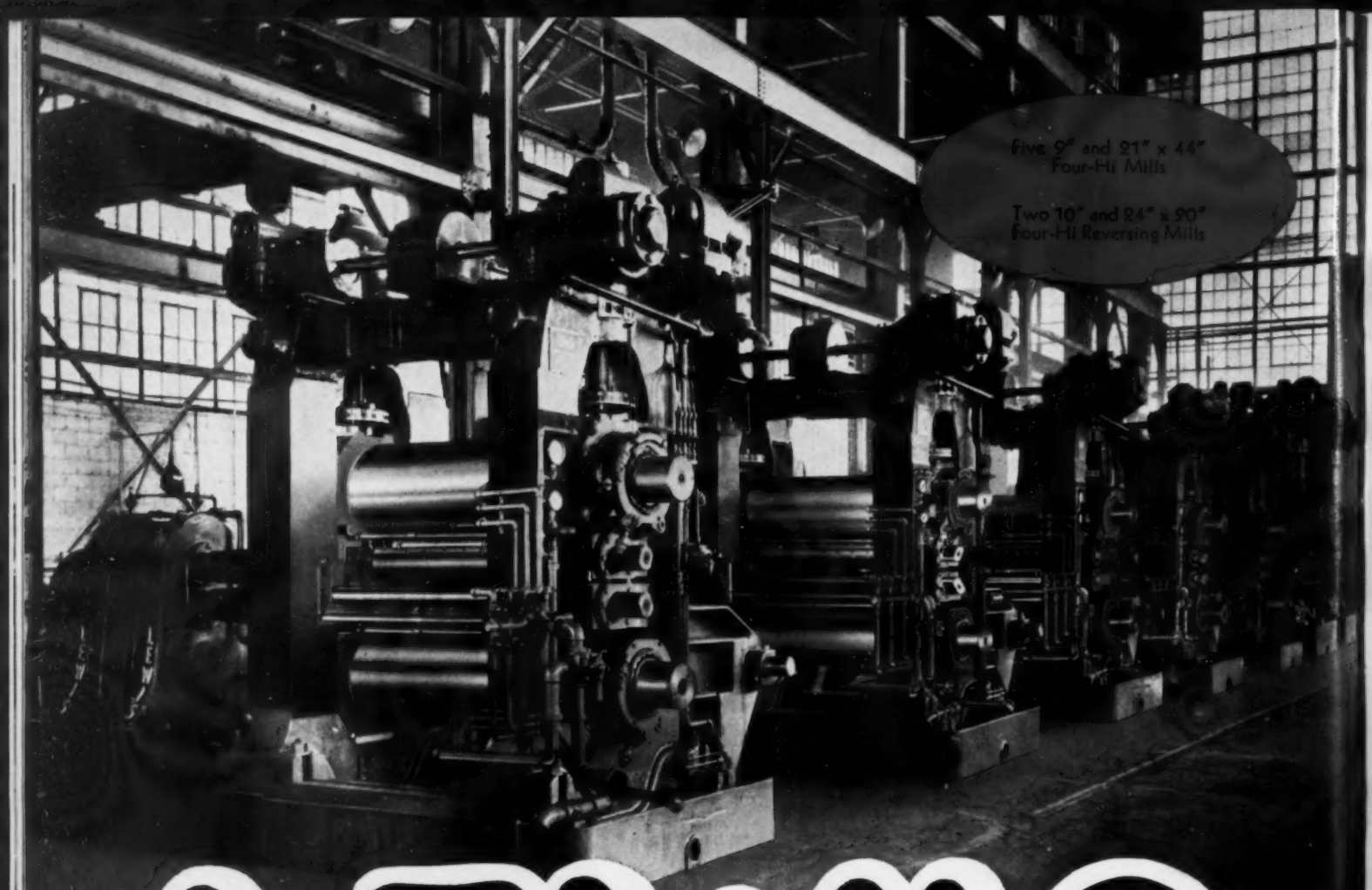

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Rolling Mill Equipment
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**MANUFACTURERS OF
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FOR THE IRON, STEEL AND
NON-FERROUS
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LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.

cluded with their regular monthly checks on Friday, June 29.

In making the announcement, Thomas E. Millsop, president, said that salaried employees who want to work instead of taking time off for vacation will be permitted to do so. They will receive extra pay at their regular rate for the amount of vacation to which they are entitled.

Mr. Millsop stated that again this year a number of salaried employees of the company have expressed a desire to work instead of taking time off for vacation.

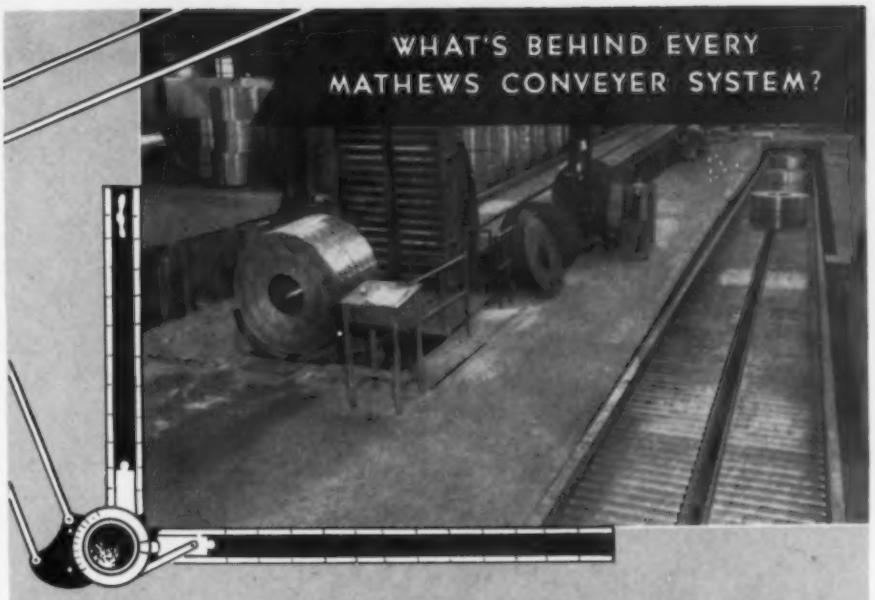
BRAZILIAN FIRM BUYS FURNACE AND COKE OVENS

▲ Koppers Co., Inc., has been authorized to design, engineer, and supervise the construction and initial operation of a blast furnace and a battery of chemical-recovery coke ovens for the Brazilian National Steel Co. at Volta Redonda, Brazil.

Work on the new 25-ft hearth diameter blast furnace, which will double the potential pig iron capacity of the Brazilian plant, will be done by Kop-

FAIRLESS TRACKAGE

This workman is sighting the alignment of a steel track crossing that will be used in the 70 miles of railroad tracks in the new Fairless works of United States Steel Co., now under construction near Morrisville, Pa. He is Bert Berkey, an employe at the company's Johnstown, Pa., plant, which is furnishing large tonnages of special trackwork sections and numerous pieces of big steel equipment for the new mill. U. S. Steel will operate an all-diesel engine division to handle the in-plant transportation at Fairless works.



COOPERATIVE PLANNING

● The best conveyer installations —those which really serve production—are the result of close cooperation between the engineers of the purchasing company and those of the conveyer manufacturer. Such systems are almost invariably the result of the combined effort of many people—people from both organizations—pooling their individual experience, and each contributing to the final result.

Mathews Engineers work with the customer toward the best solution of his problem, and it is this cooperative planning that has produced the many spectacular Mathews Conveyer Systems in operation throughout the United States and Canada. That's why, when you are buying conveyers, you can be sure of this. **If it's Mathews equipment, it has to be right.**

Engineering offices or sales agencies are located in principal American and Canadian cities.

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ELLWOOD CITY, PENNSYLVANIA

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CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

pers Freyn Engineering division with offices in Chicago, Ill.

The new battery of 21 Koppers-Becker underjet coke ovens, which may be underfired with coke oven, blast furnace, or producer gas, will carbonize 612 tons of coal per day and increase the carbonizing capacity of the Volta Redonda coke plant from 1600 to 2212 tons per day.

Included in the contract with Brazilian National Steel are additions and alterations to the coal chemicals plant to accommodate the additional capacity from the new battery of ovens.

Koppers completed the original battery of 55 ovens and the coal chemicals plant at Volta Redonda in April, 1946.

Materials for the new blast furnace and coke ovens will be procured in both the United States and Brazil.

DONORA SMOG CASES SETTLED BEFORE TRIAL

▲ L. F. McGlincy, manager of operations in the Pittsburgh, Pa., district of the American Steel & Wire Co., announced recently that the Donora smog cases have been settled. The settlement followed a conference between counsel for the parties held before Judge Owen M. Burns of the Federal District Court before whom the first case was listed for trial. Judge Burns recommended and approved the settlement.

Mr. McGlincy said: "The company was confronted with a choice between defending at considerable cost approximately 135 law suits and paying a lump sum representing a small percentage of the total amount claimed."

Mr. McGlincy indicated that by the settlement the company did not admit liability but that it was prepared to prove that the principal cause of the smog disaster of October 1948 was the freak weather condition which prevailed for an unprecedented period of five days, with a temperature inversion which served as a lid keeping within the valley all of the smog coming from the homes, the railroads, the steamboats, and the exhaust from automobiles, as well as the effluents from its plants, and that this combination of causes was established by an extensive investigation conducted by the United States Public Health Service.

FAIRLESS WORKS BUYS 16 DIESEL LOCOMOTIVES

▲ Contract awards for sixteen diesel-electric locomotives for use at U. S. Steel's Fairless Works near Morrisville, Pa., were announced by United States Steel Co. Baldwin-Lima-Hamilton Corp., of Eddystone, Pa., and Fairbanks, Morse & Co., of Chicago, Ill., shared the awards, and each will furnish eight of the diesel locomotives.

The locomotives will be 120-ton switchers with 1200 horsepower and designed for operation on standard gage tracks. Each locomotive is designed to haul a load of at least 100 standard loaded freight cars. The first locomotive will be delivered in July.

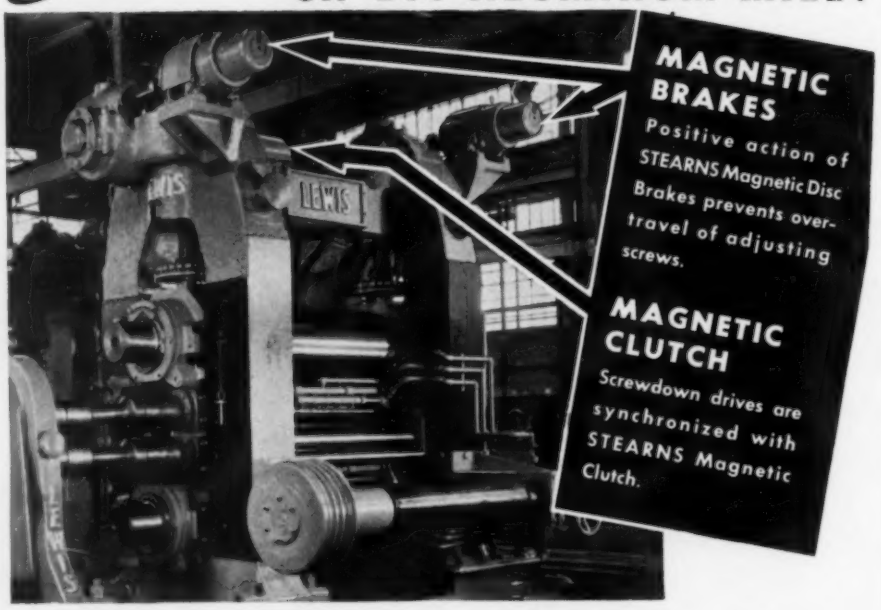
TIMKEN TO INSTALL INDUCTION STIRRER

▲ Purchase of the first induction stirrer to be ordered for a production steel-melting furnace in the United States was announced by Timken Roller Bearing Co.

Although new in this country, the induction stirrer has been under development by the Swedish Electric Co. (ASEA) for several years.

This firm has granted manufactur-

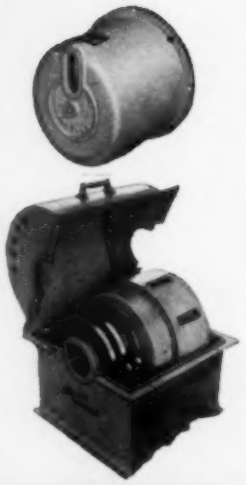
Stearns DOES DOUBLE DUTY ON BIG ALUMINUM MILL!


MAGNETIC BRAKES
Positive action of STEARNS Magnetic Disc Brakes prevents overtravel of adjusting screws.
MAGNETIC CLUTCH
Screwdown drives are synchronized with STEARNS Magnetic Clutch.

LEWIS 4-High Foil Mill

Stopping the adjusting screws on a Lewis mill and holding them positively in position is just the job for STEARNS Magnetic Disc Brakes. Designed with a quick, steady pressure that brings a fast stop in the shortest time, STEARNS Magnetic Disc Brakes prevent overtravel of the adjusting screws and thus allow for careful, positive adjustment. Suitable for horizontal or vertical applications, STEARNS brakes are available in sizes up to torques of 575 pounds feet.

Sychronizing the drive on the screwdowns of large mills requires a rugged, dependable clutch — a STEARNS Multiple Disc Magnetic Clutch. For here's a clutch that is constructed of few and simple parts with no toggles, pins, yokes, shifters or other parts to wear and get out of order. Controlled by a push-button station, STEARNS clutches are available with taper-bores, detachable magnet hub and are furnished fully enclosed in a steel housing. Available in torques and construction to meet your screwdown requirements.



Descriptive literature available. Write today for Bulletin 604-F on brakes, Bulletin 226 on clutches.

Stearns MAGNETIC MANUFACTURING CO.

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TYPICAL SEMI-CONTINUOUS ROD MILL
There's a definite PHOENIX ROLL for each ROLLING requirement
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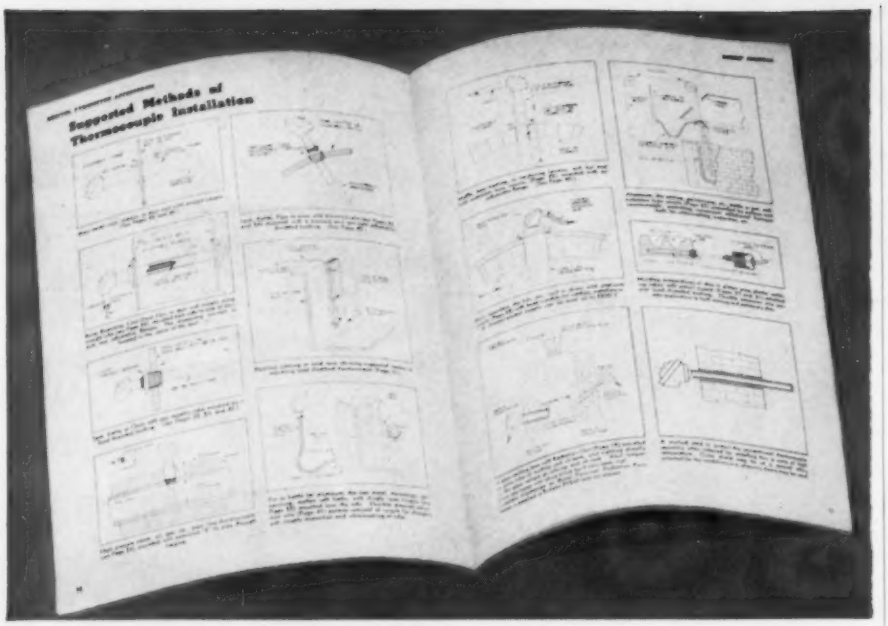
PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.



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Bristol's new engineering handbook makes correct selection and application of pyrometer supplies an easy matter. Lists the widest variety of thermocouple assemblies, pyrometer tubes, terminal heads. thermocouple wire and extension wire on the market. Address THE BRISTOL COMPANY, 123 Bristol Road, Waterbury 20, Conn. (The Bristol Company of Canada, Ltd., Toronto, Ont.)

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You save, first, by "teaming-up" your purchases of thermocouples and pyrometer accessories to take advantage of Bristol's substantial quantity discounts.

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BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

ing rights to the Elliott Co., Jeannette, Pa., to manufacture the devices for the Timken company. The Aros Electric, Inc., of New York City, is sales representative for ASEA in this country.

The stirrer will be placed in operation upon the completion of the first of three 80-ton electric furnaces which will be a major portion of the Timken company's $5,503,000 expansion of steel-making facilities.

Replacing of three open-hearth furnaces with the new electric furnaces will make the Timken steel and tube division a producer of electric-furnace steel exclusively and will increase capacity 14 per cent.

Construction on the three new electric furnaces is expected to start in January, 1952.

MEXICAN STEEL FIRM DOUBLES STRIP CAPACITY

▲ One of Mexico's major steel mills, Altos Hornos de Mexico, S. A., of Monclova, Coahuila, is doubling its capacity for the production of steel strip to help supply the nation's expanding steel requirements.

The firm has ordered from the Westinghouse Electric International Co. electric equipment to drive a new hot strip finishing mill, and new tinning and shearing lines.

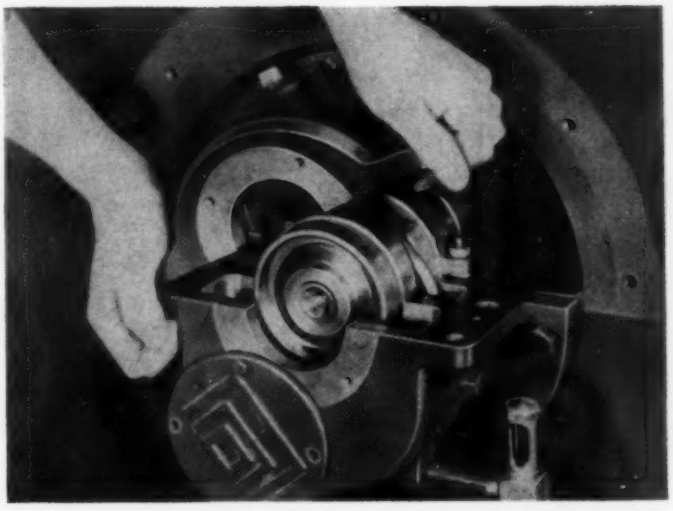
A 3000-hp main drive motor, a 2500-kw motor-generator set, switchgear, auxiliary motors and controls, and ventilating equipment have been ordered for the finishing mill. Motors and controls also will be supplied for the tinning and shearing lines. A 4000-hp turbine was ordered to supply electricity for the plant.

AIRCO IS BUILDING CALCIUM CARBIDE PLANT

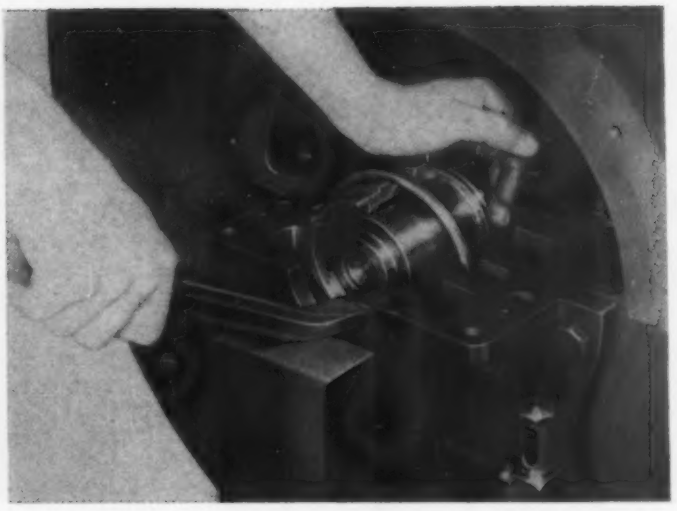
▲ Air Reduction Co., Inc., announced it will construct a new plant, costing upwards of $10,000,000 and increasing significantly the nation's supply of defense-vital calcium carbide, at Calvert City, 15 miles east of Paducah, Ky. It is to be operated by National Carbide Co., one of Air Reduction's ten operating divisions.

The new plant is to occupy part of a 1,000-acre tract fronting on the Tennessee River, with the remaining acreage being held in reserve for expansion and to accommodate indus-

TO GET AT A BEARING all you remove is the bearing cap ...IN ELLIOTT DC MOTORS!



The bracket as well as air directing baffles stay put—you don't need to touch any part of them. The photo above shows why. As soon as you raise that bearing cap, there's the bearing, completely accessible. The top half of the bearing shell can then be lifted off.



To remove the bottom half of the bearing shell, you simply take the weight of the rotor off it, roll it round to the top of the shaft, and lift it out from under the oil ring. There's a boss on the end of the shaft to take your pinchbar. That's what it's there for—you can't hurt it.

Bracket-type design with simplified accessibility

■ As with other Elliott motors with bracket-type bearing support, in the Elliott DC line both bearings can be removed and replaced with no possibility of affecting the original alignment. It's only one of many advantages that follow Elliott "Fabri-Steel" construction which immensely broadens former engineering limitations, and gives the motor designer new freedom, unshackled by old tradition.

It's a new way to build motors, and in many plants it's cutting maintenance costs to an unprecedented degree, and supplying the brand of performance that plant managers dream about.

Write for the Elliott DC motor bulletin.

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HALF CENTURY OF 1901 EC 1951 POWER PROGRESS

MR-8

tries which may locate in the area to manufacture acetylene-based synthetics.

With an initial rated capacity of 142,500 tons of calcium carbide a year, the Calvert City plant will be about the same size as the present National Carbide Louisville, Ky., plant, which pipes acetylene gas, generated by adding calcium carbide to water, to nearby plants.

Apart from its use as a chemical building block, calcium carbide is the primary source of the fuel used in the oxyacetylene welding and cutting processes—important to the metals industry as the needle, thread and scissors are to the garment maker.

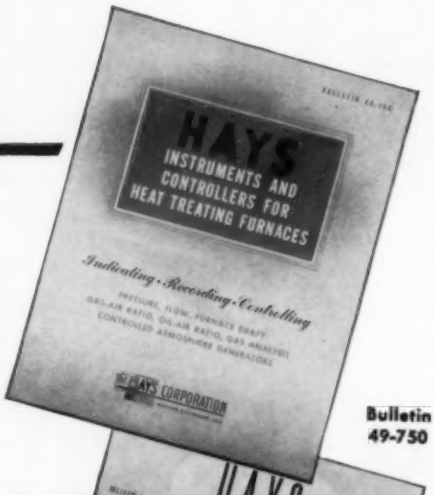
The National Carbide installation will consume more than 1,000,000 kilowatt hours of TVA electricity per day, or enough to meet the normal requirements of a city of 250,000 population. Lime and coke, the raw materials used to produce calcium carbide, will be imported from nearby areas.

Bulletins on instruments and control for 2 types of furnaces

HEAT TREATING FURNACES

A complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.).

Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers and automatic CO_2 recorders are covered.

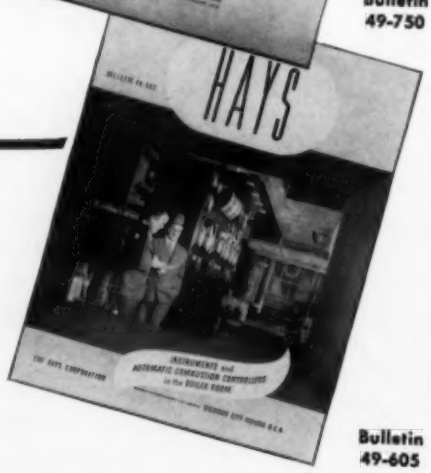


Bulletin 49-750

BOILER FURNACES

This bulletin summarizes applications of Hays centralized combustion control to chain grate, underfeed, spreader type, or lever type stokers; to attritia type, bowl type or ball bearing type pulverizers; to a wide range of oil burners including the rotary cup; and to a wide range of gas burners.

The Hays complete line of draft gages, flow gages, and meters (for high and low pressure gases and liquids), portable gas analyzers, automatic CO_2 recorders, and electronic type O_2 recorders are covered.



Bulletin 49-605

Write for these informative bulletins today.

THE **HAYS** CORPORATION

MICHIGAN CITY 13, INDIANA

combustion and industrial instruments and control

BUY SLAB FURNACES FOR FAIRLESS WORKS

▲ Four continuous slab heating furnaces to serve a new strip mill are being designed and will be built at Fairless works, Morrisville, Pa., for United States Steel Co., according to Rust Furnace Co.

Each furnace will have a capacity of 135 tons per hour, and will deliver slabs at a temperature of 2250 F.

Furnaces are of the Rust zone-controlled, triple-fired, recuperative type, and are designed to burn coke oven gas, natural gas, or fuel oil. Each will be equipped for full automatic control of temperature and furnace pressure with automatic fuel-air ratio.

Design of each furnace calls for an inside width of 22 ft with an effective length of 90 ft.

PENN OPTICAL TO USE OWN TRADEMARK

▲ Pennsylvania Optical Co., one of the country's oldest optical goods manufacturers, announced it was introducing a complete line of industrial lenses under its own trademark. For more than 45 years the company has manufactured precision ground and polished optical products, including welding lenses made for other trademarks. Now for the first time it will label each lens with "Penoptic."

MESTA TO BUILD 80 IN. STRIP MILL

▲ United States Steel Co. announced today the award of a contract to Mesta Machine Co. of Pittsburgh, Pa. for an 80-in. continuous hot strip mill at the Fairless works, Morrisville, Pa. The new mill will provide steel coils for hot rolled sheet and strip finishing facilities and for further processing in cold reduction mills.

The new mill will roll slabs from four to eight inches thick and from eight to twenty feet long into steel coils 640 ft to 3200 ft long in one continuous operation. The end product of this mill will be sheets from twenty to seventy-two in. wide and approximately one-tenth of an in. thick. The sheets arrive at the reel at speeds up to 2200 fpm.

Facilities contracted for include a vertical edger, scale breaking stand,

broadside stand, four roughing stands, six finishing stands, a run-out table, and three coilers. The overall length of the mill will be about one-third of a mile.

CRUCIBLE BEGINS NEW EXPANSION PROGRAM

▲ Crucible Steel Co. of America has begun work on a $27,250,000 program to expand its steelmaking capacity at Midland Works, Midland, Pa., some 35 miles northwest of Pittsburgh on the Ohio River. Midland works is Crucible's producer of iron and basic steels, and of volume quantities of alloy and special purpose steels.

The company's plans call for a 60 per cent increase in capacity to produce pig iron by building a new blast furnace, in addition to the two existing blast furnaces in Midland works. Open hearth production is to be increased by the replacement of six furnaces with six modern furnaces of larger size raising the open hearth capacity of the plant by about 22 per cent. Four electric furnaces are to be enlarged, increasing the capacity for electric steels by approximately 37 per cent.

A new combination bar mill consisting of a roughing stand and four stands of finishing mills will be installed to replace existing equipment. This will improve, enlarge and speed Crucible's production of large round bars, as well as augmenting its blooming mill capacity.

A merchant bar mill is to be rebuilt which will improve the quality of the product and materially increase production.

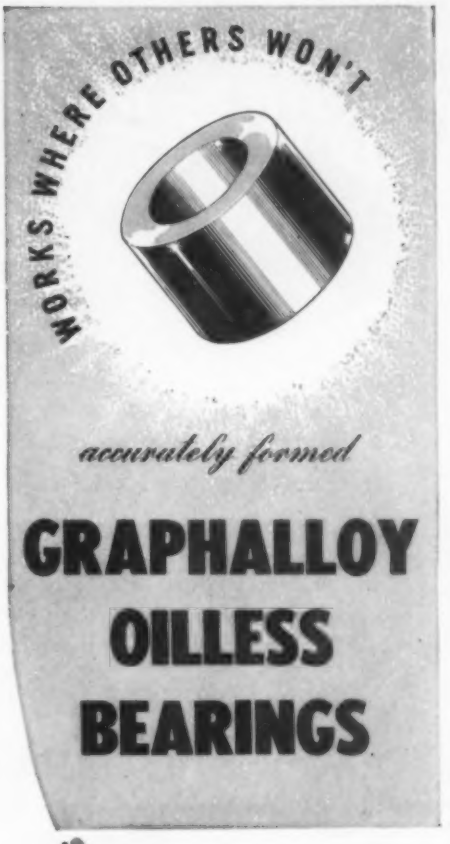
An additional modern soaking pit for the blooming mill, as well as combustion controls and other modern auxiliaries for the present pits, will be provided. These facilities will give adequate capacity for heating the increased ingot production. They supplement plans already under way to modify the blooming mill so that it may roll heavier ingots to larger section blooms and wider slabs.

The coke plant at Midland Works will be enlarged from 184 ovens to 213 ovens. At Crucible, Greene County, Pa., the company coal mine output is to be increased by the addition of trackless equipment.

The program makes provision for improvements to existing auxiliary equipment, and the addition of new

RETIRED G-E EXPERTS VOLUNTEER FOR DUTY

Twenty former General Electric engineering and sales experts (left) pose with 20 young company engineers whom they succeed as "guides" on the firm's now-famous "More Power to America Special" exhibit train. By volunteering for a three-month return to General Electric service, the retired specialists free their younger counterparts for defense engineering and production assignments.



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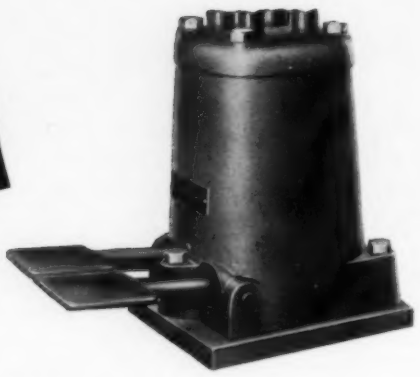

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Foot Valve

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Increase output of hammers, shears, presses, etc.

● Operators have both hands free to handle the work—speeding production. Valving mechanism has stainless steel body and push-pull rods, brass sleeves, self-sealing U-packers and many other refinements, all fully enclosed against dirt, assuring long efficient trouble-free operation. Convenient pipe connections. No metal to metal seating. ⅜" to 1" sizes, 3-way and 4-way, neutral position and regular actions. *Write for full details.*

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auxiliary facilities, including blast furnace turbo-blowers and a new sintering plant; two new boilers; larger ladles and ladle cranes in the melting departments, as well as rebuilding of existing equipment; a new charging machine in the open hearth department; new equipment and improvements for handling ingots; added water supply installations; three additional 95 ton diesel-electric locomotives; billeteers and cold saws.

In addition to the production improvements described above, the program provides for additional equipment and improvements to existing service facilities auxiliary to the operating department. Three more 95-ton diesel-electric locomotives will be added to the Midland works rail transport system. Two new Babcock & Wilcox boilers equipped to burn blast furnace gas will provide steam for the new blast furnace and other plant purposes. Improvements will be made in water supply and water clarification systems of the plant. In the conditioning department new Bonnot Co. "Billeteers" and cold saws will be installed.

U. S. STEEL BUYERS MOVE TO NEW BUILDING

▲ Formerly located in three separate buildings, the purchasing offices of three principal subsidiaries of U. S. Steel have now all moved to the new 525 William Penn Place Building, Pittsburgh, Pa., bringing them together in one location for the first time.

The purchasing offices of United States Steel Co., which resulted from a merger of Carnegie-Illinois Steel Corp., U. S. Steel Corp. of Del., H. C. Frick Coke Co., and U. S. Coal and Coke Co., are now located on the 12th floor. In addition, the purchasing offices of American Bridge Co. and National Tube Co. are both on the same floor.

Other U. S. Steel offices which have moved to the new location include: Pittsburgh district sales of United States Steel Co., 9th floor; coal chemical sales division, United States Steel Co., 10th floor; Pittsburgh district operations, sales and traffic, American Steel & Wire Co., 9th floor; Pittsburgh district contracting department, marine and tower departments, American Bridge Co., 10th floor; Pittsburgh district sales and Christy Park sales, National Tube Co., 10th

floor; Pittsburgh district sales and tubular department, Oil Well Supply Co., 10th floor; Pittsburgh district sales, Universal Atlas Cement Co., 10th floor; and traffic department, United States Steel Co., 11th floor.

CORROSION SCIENTISTS TO MEET IN JULY

▲ For a number of years, the American Association for the Advancement of Science has sponsored research conferences on chemical subjects. Attendance is by invitation and is normally restricted to about 100 persons. The 1951 meeting dates will be July 23, 24, 25, 26 and 27.

Research workers in corrosion who are interested in attending this conference should immediately send their request to the conference director, Dr. W. George Parks, Rhode Island State University, Providence, R. I.

RAIL MOVEMENT OF ORE TO BE CONTINUED

▲ All-rail shipments of iron ore from mines of Oliver Iron Mining Co. to eastern steel mills will be continued this season. The history-making winter rail ore movement ended last month when the ore type hopper cars were returned to their owner roads for regular spring maintenance and repair work needed to fit them for their job of moving the millions of tons of ore this year from the mines to vessel loading docks.

Oliver's presently scheduled rail ore shipment will average between 400 and 500 cars a day. Shipments will be directed from the Gogebic and Mesabi Ranges to U. S. Steel's furnaces in the Pittsburgh, Youngstown and Chicago area and to other iron and steel producers who depend upon Oliver for part of their iron ore supplies.

The rail movement of ore is the result of the current intense demand for iron ore needed to fulfill the requirements of our defense program and essential civilian needs. Last year the all-rail shipments of 1,500,000 tons augmented the lower than normal volume of lake shipments which were the result of bad weather and the late opening of the lake navigation season.

As in last year's movement, the ore will be shipped in standard gondolas and hopper cars. New techniques have been developed for blending the ore and estimating the tonnages loaded, so that both proper grading and speedy loading can be achieved.

The entire rail movement will be divided among the various railroads originating shipments out of the head-of-the lakes area. It is of course too early now to estimate accurately the total tonnage of the all-rail movement this shipping season, but it is expected that the total industry shipments will exceed 4,000,000 tons. The extent of the rail movement will be determined by the ability of the railroads to supply gondola and hopper-bottom cars.

BRAINARD STEEL CO. RELOCATES AT NEW PLANT

▲ The Eichleay Corp. of Pittsburgh has been engaged to lay foundations and relocate and do the mechanical installation of machinery and equipment at the new Warren, Ohio, plant of the Brainard Steel Co. The project includes the moving of heavy equipment from the Farrell, Pa. and Orrville, Ohio plants as well as from the old plant in Warren.

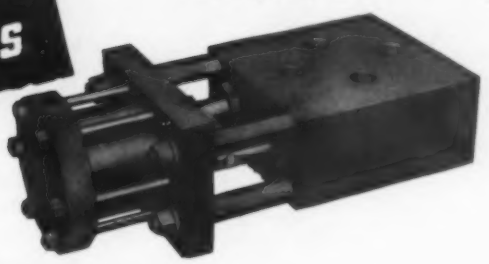
CONNORS STEEL TO INCREASE CAPACITY

▲ Connors Steel Co., Birmingham, Ala., a division of H. K. Porter Co., Inc. has let contracts for its $2,000,000 plant expansion. Rust Engineering Co. was awarded the contract covering the engineering and installation of the additional electric furnace for enlarged steel capacity, an additional billet heating furnace, and the modernization of the present heating furnace. Also included are an 18 in. breakdown mill, new hot bed and coiling facilities, and enlargement of the laboratory and metallurgical facilities.

Treadwell Engineering Co. will furnish the breakdown mill, manipulator, and gear set. The motor drive will be produced by Westinghouse Electric Corp., while Pittsburgh Lectromelt Furnace Corp. will build the new 15-ton electric furnace. Bloom Engineering Co., Inc. designed the new reheating furnace and redesigned the old one. The 25-ton crane in the furnace building will be supplied by Whiting Corp.

When completed, Connors' capacity will be increased by 40 per cent.

Quick-As-Wink AIR AND HYDRAULIC Control Valves



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Personnel News...

W. F. Tuttle has been appointed chief engineer of Armco Steel Corp., Middletown, Ohio. Mr. Tuttle replaces **E. N. Millan** who has asked to be relieved as the active executive head of the engineering division of the company.

Mr. Millan has agreed to continue to serve Armco in a consulting and advisory capacity on engineering problems. Mr. Tuttle had been assistant chief engineer.

J. H. Strassburger has been named assistant general superintendent of all Weirton Steel Co. mills effective immediately. **George L. Campbell** has been promoted from assistant manager of the service and maintenance department to manager of the department. **Fred J. Truesdale** is advanced from assistant to the manager of the service and maintenance department to assistant manager. **James D. O'Roark** leaves his position as electrical superintendent to become assistant to the manager of service and maintenance.

Robert T. Eakin, 35-year-old metallurgical engineer who joined Allegheny Ludlum Steel Corp. as a student trainee in 1940, has been appointed manager of the Brackenridge, Pa., plant succeeding **George Evans,** who becomes special consultant to the vice president in charge of operations.

Francis J. Myers, former U. S. Senator of Pennsylvania, was elected a director of the Alan Wood Steel Co., Conshohocken, Pa., at the annual meeting held recently.

E. Kirk Harris, superintendent of the South Chicago, Ill., coke plant for Youngstown Sheet and Tube Co., retired recently after 35 years of service. He was superintendent of the plant 21 years.

D. H. W. Fisher has been appointed assistant to the general works manager of Oliver Iron & Steel Corp., Pittsburgh, Pa.

John L. Warner has been appointed superintendent of the South Chicago, Ill., coke plant of Youngstown Sheet and Tube Co. He succeeds **E. Kirk Harris** who retired recently.

Roy H. Nelson, assistant superintendent of Youngstown Sheet and Tube Co.'s Brier Hill blast furnaces for 10 months, has been transferred to Hubbard, Ohio, as assistant superintendent of the Hubbard furnace.

George T. Fonda was named vice president of the Weirton Steel Co. The industrial relations department of Weirton has now been reorganized into five separate divisions. Mr. Fonda has been with Weirton Steel for the past 18 years as assistant to the president. In his new capacity he will be responsible for the administration of all activities classified as industrial relations. In the reorganization of the industrial relations department, five men have been named to head up the various phases of the work. They are: **Ray M. Corll,** director of employee relations; **C. B. Dodd,** director of insurance, pensions and safety; **E. M. Mentzer,** director of employment services; **John A. Jones,** director of publications and publicity; and **Dr. J. L. Thompson,** director of medical services.

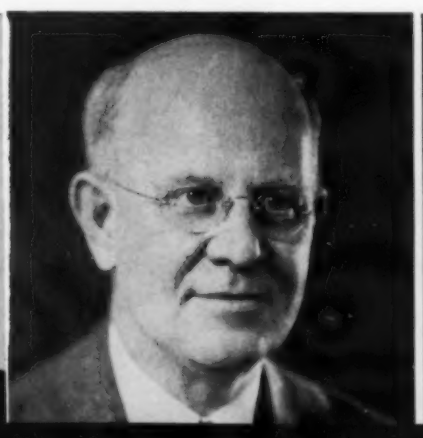
Ralph W. Rausch has been appointed consulting engineer of Link-Belt Co. His headquarters will continue to be at the Pershing Road plant, Chicago, Ill., of which he became assistant chief engineer in 1933 and chief engineer in 1947. **Joseph J. Richard,** heretofore executive assistant chief engineer of the Pershing Road plant, has been appointed chief engineer of this plant to succeed Mr. Rausch.

Roy A. Hunt, president of Aluminum Co. of America since 1928, was named chairman of the executive committee and **I. W. Wilson,** senior vice president, was made president of the company. **Arthur V. Davis** continues as chairman of the board.

W. Forman Bickel has resigned as treasurer of Harbison-Walker Refractories Co., Pittsburgh, Pa. Mr. Bickel became associated with the company in 1917 and was employed in the sales and operating departments until his election as treasurer in 1927. He was elected a director in 1931. While serving in the operating department, he was a district works manager for eight years. With a total service to the company of 34 years, he will continue to serve as a director. **Lawrence E. Mock** was elected treasurer to succeed Mr. Bickel.

Fred M. Gillies, executive vice president, was elected to the board of directors of Acme Steel Co. Works

W. F. TUTTLE | E. N. MILLAN | J. H. STRASSBURGER | J. D. O'ROARK



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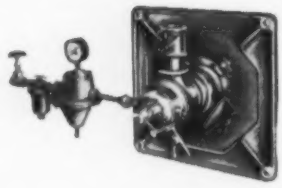

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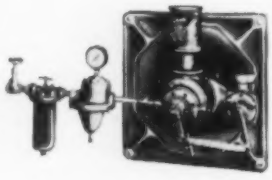

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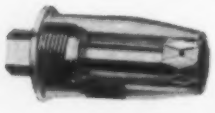

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manager **William C. Fork** was elected vice president. Mr. Gillies went to Acme Steel in May, 1950 after 29 years with Inland Steel Co., having served as plate mill superintendent, assistant general superintendent, gen-

WILLIAM C. FORK

eral superintendent and works manager. In March, 1949, he took a leave of absence to accept an appointment as production chief of the Allied Steel Commission in Germany. Mr. Fork has been works manager at the Riverdale plant and a director of the company since 1949. Mr. Fork, oldest employee in terms of service, joined Acme Steel May 21, 1908 as a handy man. He worked successively as machine operator, machinist, draftsman, engineer, chief engineer, assistant superintendent and superintendent of the hot mills, and general superintendent until his appointment as works manager in 1947.

L. B. Gezon and **O. A. Huntsman** have been appointed sales manager and assistant sales manager, respectively, of the metal-clad and switchboard section of General Electric Co.'s switchgear divisions at Philadelphia, Pa.

E. C. Girty was named vice president in charge of

E. C. GIRTY

operations for National Roll and Foundry Co. Mr. Girty has been general superintendent of the National plant at Avonmore since 1949. He had previously been with Pittsburgh Rolls division of Blaw-Knox in the

capacity of research metallurgist, production development engineer and superintendent. **W. E. Curran,** who has been with the National organization since 1942, was promoted to general superintendent and **J. C. Kepfer** was named executive assistant.

Robert D. Lawson was named sales manager of Norton Co.'s grinding machine division. Mr. Lawson, Chicago district manager for the company's grinding machine division since 1946, will replace **C. Denson Day,** who has resigned to accept a position as vice president with Machinery Associates, Inc. of Philadelphia, Pa. Mr. Day has been with Norton Co. since 1926.

W. E. Blowney has been appointed divisions engineer of General Electric's steam turbine, generator and gear engineering divisions at Lynn, Mass., and **L. B. Wales** has been appointed division engineer of the company's auxiliary turbine engineering division at Fitchburg, Mass.

Floyd W. Crouch was named chief metallurgist and **Jaye S. Gamble** has been appointed assistant chief

FLOYD W. CROUCH

metallurgist at National works of U. S. Steel's National Tube Co., McKeesport, Pa.

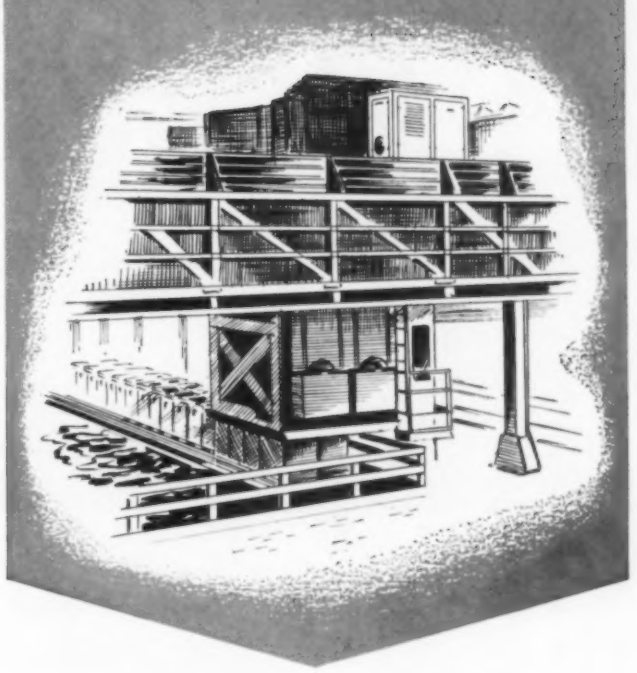
Gerald D. Dodd, assistant to the president of Foster Wheeler Corp., assumed charge of manufacturing at the company's Carteret, N. J. and Dansville, N. Y. plants, succeeding **William Lonsdale,** vice president in charge of manufacturing, who retired from active duty on May 1, 1951. Mr. Lonsdale who has passed the mandatory retirement age of 70 years will be retained as a special consultant prior to his full retirement.

Donald MacArthur was appointed manager of the sales department, central staff of Koppers Co., Inc. **T. H. Cable,** who has been with the sales department since November 1949, was named manager of the international product sales section of the department.

Stanley F. Krzeszewski was elected a vice president of American Wheelabrator and Equipment Corp., 500 South Byrkit Street, Mishawaka, Ind. For the past 5½ years he has been factory manager, and will continue with these duties.

Robert F. Lamb has been appointed sales and serv-

LINTERN Aire-Rectifiers Proved On Soaking Pit Cranes Throughout the Past Decade



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ice engineer for Esterline-Angus Recording Co., Inc., in western New York. Mr. Lamb will be located at 1807 Elmwood Ave., Buffalo 7, N. Y.

Arthur W. Thornton has been appointed division superintendent, pipe production, finishing and shipping at National works, McKeesport, Pa., National Tube Co.

ARTHUR W. THORNTON

Norman W. Foy, of Cleveland, was appointed as assistant administrator to head the Metals and Minerals Bureau, of the National Production Authority. Mr. Foy, who was an official of the War Production Board for several years heads the bureau which includes the iron and steel division, copper division, aluminum division, tin, lead and zinc division, and miscellaneous metals and minerals division. Mr. Foy is on leave from his post as general manager of sales for the Republic Steel Corp.

William B. Kennedy was named division superintendent in charge of blast furnaces, open hearth furnaces, bessemer converters, and rolling mills at National works, McKeesport, Pa., National Tube Co.

WILLIAM B. KENNEDY

L. B. McKnight was elected to the newly created position of executive vice president of Chain Belt Co., Milwaukee, Wisc. Mr. McKnight has served in various managerial capacities since joining the company in 1927

and has been a vice president and director since 1948.

Herman A. Bottenhorn has been appointed chief engineer of Loewy Rolling Mill division, Hydropress, Inc., New York, N. Y.

C. B. Schmidt has been elected president of De Laval Separator Co., New York, N. Y. Mr. Schmidt

C. B. SCHMIDT

has been associated with De Laval for the past 29 years. He started with the company as a young salesman at the New York office and was then transferred to the Chicago office. Subsequently he became manager of the industrial department at Chicago and following this he served for 14 years as general manager of De Laval's western division. In 1945 he was recalled to New York to assume the office of vice president. **George W. Smith** has been elected chairman of the board of directors of De Laval Separator Co. and Mr. Smith is also president of the De Laval Steam Turbine Co., Trenton, N. J. **George C. Stoddard,** who retires as president and director after 30 years of active association with the com-

GEORGE W. SMITH

pany, will continue to serve in an executive advisory capacity.

John Wiehe and **Walter Wenzel** have been named heads of a new plant engineering and planning department at Allis-Chalmers Norwood, Ohio, works. The new department has been set up under the supervision

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- FALCON COOLING PLATES, both Bosh and Inwall - because they are made without those leak producing anchors and chaplets.
- FALCON PLATES are all cast without anchors and chaplets—one homogeneous casting with uniform wall thicknesses.

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- FALCON PLATES are free from sand inclusions and metal oxides.
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of the general superintendent, to handle further planning in a modernization program underway at the works. The program includes erection of a new 80 by 210-ft non-ferrous foundry building, which is expected to be in operation during the third quarter in 1951, and a new oil storage building.

John Romano was named general sales manager of Delta-Star Electric Co., a division of H. K. Porter Co. **R. S. Keeler** has been named manager of utilities sales

W. H. BOYCE

and **W. H. Boyce** was appointed manager of the industrial division.

Luke E. Sawyer, formerly executive vice president of Babcock & Wilcox Tube Co., was elected president; **Alfred Iddles,** formerly president was elected chairman of the board; **Isaac Harter,** formerly chairman was named a consultant to the company and **Edward A. Livingstone,** vice president assigned to sales was given broader organizational responsibilities.

Birger Engstrom has been elected president of McDowell Manufacturing Co., Pittsburgh, Pa. He succeeds **W. R. Schuchman,** who becomes chairman of

BIRGER ENGSTROM

the board, after having served eleven years as president. Mr. Engstrom, a graduate of the University of Pittsburgh, has been at McDowell in various capacities, since 1927. Prior to his election as president, for eleven years he was vice president and general manager of the company.

William F. MacDonald was elected as president of E. F. Houghton & Co. of Canada, Ltd., Toronto, Ontario, Canada, succeeding the late **G. W. Pressell,** former president. **E. H. MacInnis** continues as vice president and sales manager.

L. W. Mercer has been elected to the newly created post of executive vice president for Square D Co., Detroit, Mich. Formerly vice president and general manager of the switch and panel division in Detroit,

L. W. MERCER

Mich., Mr. Mercer will now assume overall responsibility for direction and coordination of the company's sales, engineering and production activities. **F. H. Roby** has been elected vice president in charge of sales and a director. Mr. Roby joined the Square D organization in 1933 immediately after obtaining his electrical engineering degree. **L. G. Maechtlen** has been elected vice president and director. Starting with the company more than twenty years ago as a design engineer, Mr. Maechtlen has served as Los Angeles plant works manager, Los Angeles territory manager and western sales manager. He will continue, in Los Angeles, Calif., as western

F. H. ROBY

sales manager and assistant to the vice president and general manager of the western division.

Joseph Malborn, a consultant for Davy-United Engineering Co., Ltd., Sheffield, England, is back in the

UNIFORM
descaling
with the
Spraying Systems
Descaling Nozzle

This hardened stainless steel nozzle provides a constantly uniform flat spray for clean descaling operations . . . all streaking is eliminated. Available in wide range of capacities.

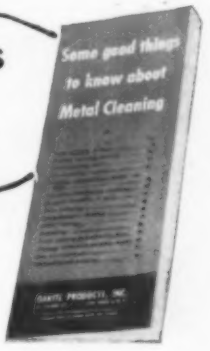
LARGE DIAMETER ORIFICE

Note that the orifice is almost circular in shape . . . far less tendency to clog than the "old style" slotted orifice. Initial cost is lower. Maintenance cost is lower.

Write for complete information on this quality built nozzle and its large capacity strainer and adapter. Ask for Catalog 22 and Data Sheet 3997.

SPRAYING SYSTEMS CO.
3262 RANDOLPH STREET
BELLWOOD, ILLINOIS
(Suburb of Chicago)

WHICH SOILS ARE HARDEST TO REMOVE?



- ☐ buffing compound residues
- ☐ pigmented drawing compounds
- ☐ oils and greases
- ☐ heat scale
- ☐ rust, oxides
- ☐ carbon smuts
- ☐ tarnish
- ☐ flux residues
- ☐ rust preventives

Technical Service Representatives in Principal Cities of U. S. & Canada

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE

OAKITE PRODUCTS, INC.
19 Thames St., New York 6, N. Y.

Tell me about Oakite methods for removing the following soils:

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RED CIRCLE
Rolls
ALLOY-CHILLED

CHILLED and
ALLOY IRON
ROLLS

Rolling Mill
Machinery

GRAY IRON
CASTINGS

HYDE PARK FOUNDRY & MACHINE CO.
HYDE PARK, PA. (PITTSBURGH DISTRICT)

BROWNING
MILL TYPE CRANES have
Plenty of Strength WHERE
STRENGTH IS NEEDED!

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

Write for our Bulletin "E".

"Built as you yourself would build them"

VRB
VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

United States for an extended stay. Mr. Malborn will make his headquarters at United Engineering and Foundry Co., 948 Duquesne Way, Pittsburgh 22, Pa.

Norman A. Strang has been appointed advertising manager of SKF Industries, Inc., Philadelphia, Pa.

NORMAN A. STRANG

He succeeds **Robert C. Byler,** who died recently from a heart attack.

S. S. Burns has been appointed chief engineer of the Marathon Electric Manufacturing Corp., Erie, Pa. Mr. Burns was formerly professor of electrical engineering at Newark College of Engineering. He was also associated with Elliott Co. as a consulting engineer and prior to that, a design engineer with the Crocker-Wheeler Electric Manufacturing Co.

John H. Mackey has been appointed assistant superintendent of the Brier Hill blast furnaces of Youngstown Sheet and Tube Co. He succeeds **Roy H. Nelson** who recently was appointed assistant superintendent of Hubbard blast furnace.

W. P. Snyder III was elected president of Shenango-Penn Mold Co., Pittsburgh, Pa., succeeding **Harry S. Bradley,** who is retiring as active head of the company. Mr. Snyder has been with Shenango-Penn since 1938, except during the three years when he was in the United States Navy during World War II. He started in the operating departments at the blast furnaces and ingot mold foundries and has been a vice president since 1946.

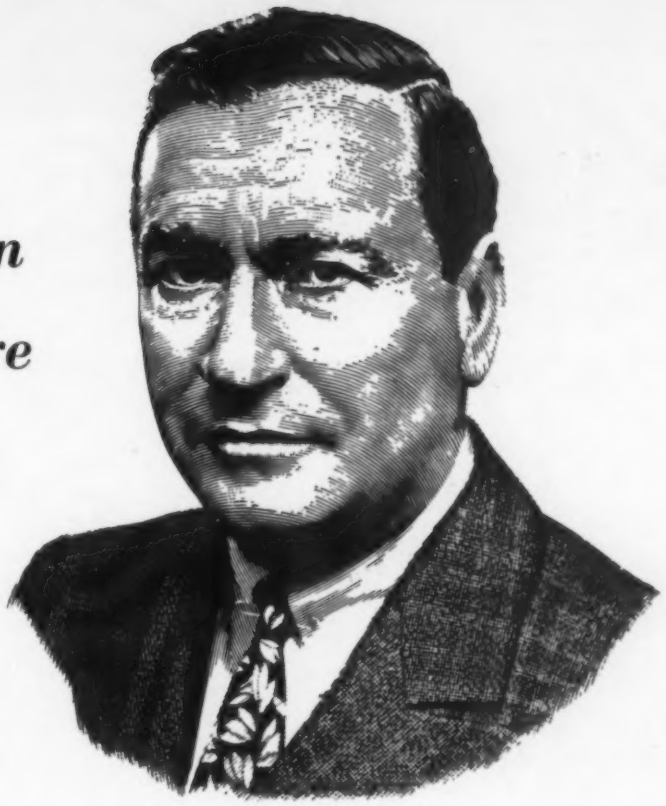
Obituaries

Robert C. Byler, 61, advertising manager, SKF Industries, Inc., Philadelphia, died of a heart attack March 27. He had been associated with the ball-bearing manufacturing firm for 36 years.

Guy A. Moffett, 50, recently appointed assistant manager of engineering of the General Electric Co.'s control divisions at Schenectady, N. Y., died recently after a short illness. Mr. Moffett was a G-E employee for nearly 27 years.

R. H. Currie, 64, died on April 9, 1951. Mr. Currie was, until his retirement on January 1, 1951, superintendent of shops, maintenance division, U. S. Steel Co., Duquesne, Pa. He had been an employee of U. S. Steel since 1908.

"You Build for your own and your country's future when you save . . ."



BENJAMIN F. FAIRLESS

President, U. S. Steel Corporation

"A free economy, such as ours, is built on the savings of the people. And the future security of America depends on the initiative and the growth of every citizen. We in U. S. Steel encourage our employees to join the Payroll Savings Plan, and we are proud that the National Tube Company, one of our subsidiaries, was the first of the large industrial companies of the nation in 1950 to have more than 80% of its employees participating. Remember, you build for your own and your country's future when you save."

Mr. Fairless is not expressing a personal opinion, nor is he speaking for other far-seeing executives when he tells you that our economy is built on the savings of the people and a man builds for his own and his country's future when he saves.

Actually, Mr. Fairless is merely putting in words the thoughts and action of the millions of employed men and women who *now hold* more than 50 billion dollars in U.S. Savings Bonds.

$50,000,000,000! Who *sold* all those bonds to millions of people? The answer is, nobody sold them.

80% of the employees of the National Tube Company . . . 75% of the employees of Carnegie-Illinois Steel Company . . . thousands of employees of other U.S. Steel subsidiaries . . . more than 8 million employees of other companies bought U.S. Savings Bonds and are buying them every month on the easy, automatic Payroll Savings Plan. Their employers merely offered these men and women an opportunity to save for their future. There was no pressure, no emotional appeal.

How does employee participation in *your* Payroll Savings Plan match up with the 80% of National Tube, the 75% of Carnegie-Illinois? Or, perhaps you are one of the relatively few large companies that do not have a Plan? In either case, wire or write, Savings Bond Division, U.S. Treasury Department, Suite 700, Washington Bldg., Washington, D.C. Your State Director is ready to help you with a package plan—application blanks, promotional material, practical suggestions and all the personal assistance you may desire.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the G. M. Basford Company and

IRON AND STEEL ENGINEER

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

Illustrated is a 100-ton, 80′-0″ span, 4-girder type Ladle Crane and a 7½-ton, 26′-0″ span Floor Charger.

BUILT BY MORGAN Engineering

Morgan equipment is built to last a long time as Morgan engineers rely upon a highly skilled shop organization, modern equipment, and progressive ideas in building Morgan steel mill machinery.

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO
PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

GAS-TURBINE GENERATOR

▲ Sale of the largest gas turbine-generator yet ordered for the commercial generation of electric power was announced recently by Westinghouse Electric Corp.

The unit, a 15,000-kw machine, will be installed in the Bartlesville area of the Public Service Co. of Okla. Natural gas from the Oklahoma fields will provide the heat energy the new turbine will convert into electrical power. It is scheduled for delivery from the Westinghouse steam division in about three years.

The 700,000-lb turbo-generated installation will consist of the gas turbine as the primary source of power, driving a hydrogen-cooled generator. The gas turbine will comprise high and low pressure turbines driving high and low pressure compressors, respectively, with the high-pressure turbine also connected to drive the generator. Intercoolers will reduce the temperature of the compressed air between stages of compression, and a regenerator will apply exhaust-gas heat to the air before it enters the combustor to reduce consumption of fuel.

The turbines will operate at a temperature of 1350 F—300 degrees higher than even the hottest steam temperatures in use today in electric generating stations, and about twice as high as the temperature of the average steam generating plant. Speed of the turbine will be 3600 rpm. At full load the compressors will draw in seven and a half tons of air every minute.

The high-temperature power-plant is an outgrowth of 12 years of Westinghouse research and development work that has also led to design of the world's most powerful production turbojet aircraft engine and to construction of a gas turbine-powered locomotive now on rail test.

Experimental industrial gas turbines designed and built by Westinghouse have been under operation and study at steam division headquarters, and in commercial service in the field for several years. A 2000-hp unit yielded field service data by driving a compressor on a mid-western natural gas pipe line; and other units have been put through thousands of hours of simulated service operation on the company's test stands.

DIESEL FORK TRUCK

▲ A new industrial fork lift truck, powered by a diesel engine and equipped with a hydraulic transmission was announced by the Philadelphia division, Yale & Towne Manufacturing Co. Called the "Diesel-Lift," this new truck is specifically designed for applications where fire hazards exist, where there is a limited amount of fresh air, and in outdoor areas where continuous heavy-duty operation is a necessity. This is the first unit of this type commercially available in the United States.

Designed principally for outdoor use, the new Yale truck utilizes a Hercules six cylinder diesel engine with a continuous rating of 70 hp.

All power impulses from the engine are transmitted through a double impeller fluid coupling. There is no unyielding metal to metal driving connection. This fluid coupling, due to its hydraulic balance, eliminates chattering, stalling and stumbling, damaging starts and stops and assures the availability of full engine power for heavy pulling and steep ramp work.

This new diesel-powered fork truck is designed for applications where fire hazards exist.

The smooth operation thus achieved lengthens clutch life five to eight times and reduces wear and tear on other vital truck parts. This means longer truck life and lower maintenance costs.

The power plant of the new Yale truck also features large hypoid gearing of the type usually found in over-the-road highway carriers. Hydraulic brakes assure equalization of braking pressure and the smooth, even stops that prevent load shifting and damage.

SOLDERS GLASS TO METAL

▲ General Electric Co. engineers can solder glass to metal in a process which makes a bond stronger than the glass itself.

The method, which can also be used to solder metal to ceramics and carbon, was originated by scientists of the G-E research laboratory, and is currently being tested for industrial applications by the company's general engineering laboratory.

The glass and metal areas to be soldered are painted with a thin layer of titanium hydride, and solder is placed upon both painted areas. The parts are placed together and then heated under a vacuum.

When the temperature reaches about 900 F, the titanium hydride decomposes. This causes the solder, which has already become molten, to adhere to the titanium-painted areas of both glass and metal. A strong, tight bond is formed upon cooling.

By using soft metal solders, it is possible to subject this glass-to-metal seal to rapid temperature changes without danger of cracking, despite the wide difference in temperature expansions between glass and metal. This is possible because the differences in movement are absorbed by the solder.

The new technique is now in use in aircraft ignition systems, and laboratory investigations have suggested possible applications in the manufac-

ture of transformers, capacitors, and electric motors. These possibilities are now under consideration, according to laboratory engineers.

AIR-COOLED CRANE CABS

▲ Cranes handling hot metal at the new Fairless works of the U. S. Steel Co., Morrisville, Pa., are to be equipped with Lintern "Aire-Rectifiers." These are of the split system type: The condenser is located at any convenient place on crane and evaporator (cooling coil) is placed in cab. The two units are connected with refrigerant lines properly secured and protected against breakage. Condensers are air-cooled, assuring trouble-free service with but little maintenance.

The "Aire-Rectifiers" are claimed to hold the cabs at a cool 85 F and relative humidity of 30 to 50 per cent at ambient temperatures of 170 F without excessive head pressures or wear on the machine. Separation of the conditioning system into two parts gives flexibility in locating the equipment without penalizing performance, and it permits improved weight distribution.

Inspection is made more convenient for the serviceman by separation of the units, since the condenser may be placed high on the crane, away from radiant heat, while the air filters and cooling coil are grouped compactly in the cab. The protection afforded this latter equipment by the cool cab actually reduces inspection requirements and maintains high efficiency.

SENDZIMIR MILL OIL

▲ To meet the unique demands of the Sendzimir precision cold strip rolling mill for a combination bearing lubricant and roll oil, a new dual-purpose oil, "Roltex" oil, has been developed and marketed by Texas Co.

Texaco's versatile new lubricant underwent considerable laboratory development after studies of a variety of Sendzimir mill installations and applications revealed that the oil would have to perform these two essential functions: lubricate the anti-friction bearings, and act as a coolant for the strip while preventing "heat streaking."

The new oil incorporates the following characteristics necessary to the efficient operation of a Sendzimir mill:

It has a well-balanced film strength which permits proper lubrication of the heavily loaded anti-friction bearings without eliminating the essential friction necessary to the rolling operation.

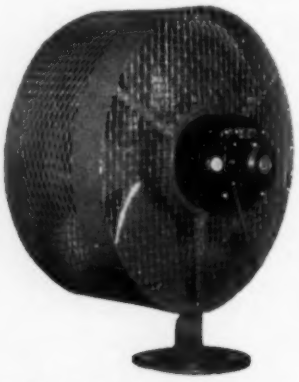
It acts as a coolant on the strip during rolling, is non-staining to the metal, provides rust protection during shutdowns, does not fog or foam, is oxidation resistant, and has a viscosity which permits easy removal by the rubber scraper.

NEW SKF TRADEMARK

▲ SKF Industries, Inc., announces that it is placing in production ball and roller bearings to be marketed in the United States and foreign countries under an additional trademark.

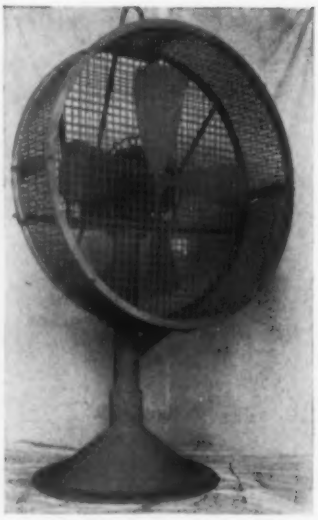
Richard H. DeMott, president, said the trademark, "Hess-Bright," is a name well known in American industry. The Hess-Bright Manufacturing Co. was one of the nation's earliest anti-friction bearing producers, becoming affiliated with SKF in 1916.

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

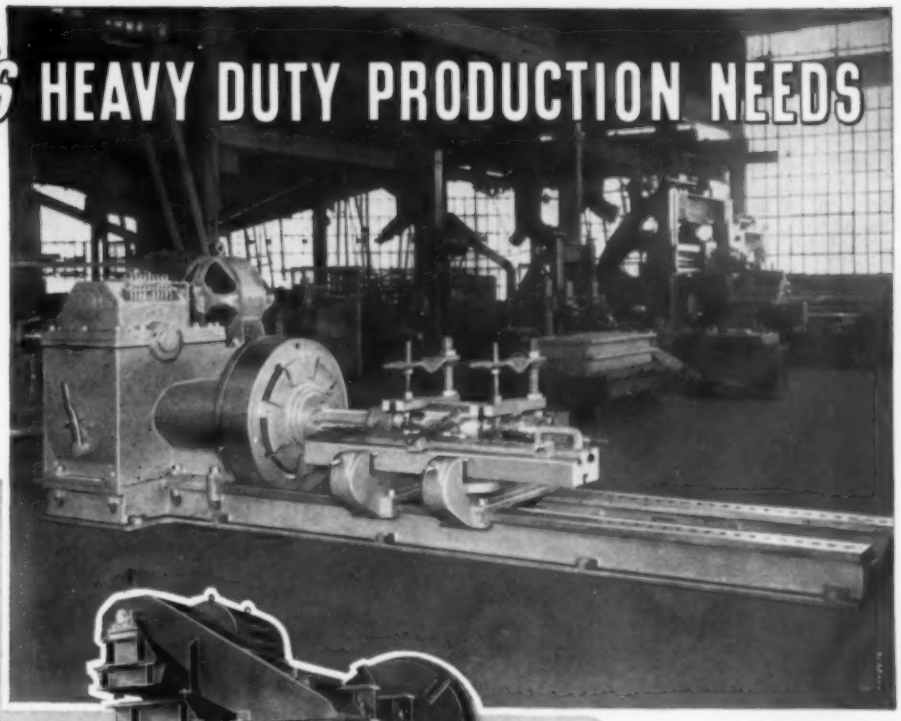
Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

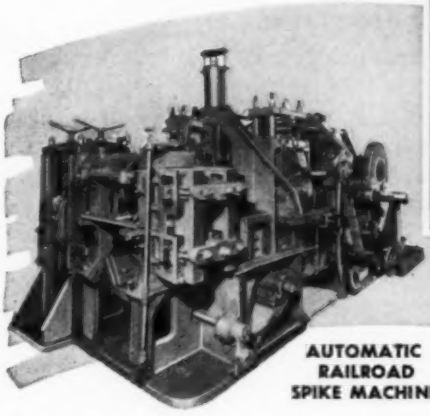
PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

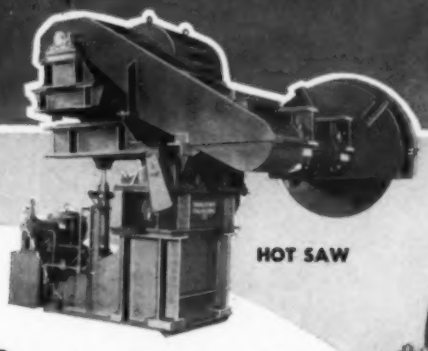
SERVING *TODAY'S* HEAVY DUTY PRODUCTION NEEDS



18" WORM DRIVE ROLL LATHE



AUTOMATIC RAILROAD SPIKE MACHINE



HOT SAW

WELDED GEAR REDUCER

SCRUBBER and CLEANING LINE

INGOT BUGGY DRIVE

Check this List for the Products You Need

PARALLOY ROLLS (Pinch, Coiler, Tension, Steel Mill)
HYDRAULIC SLAB AND BILLET PILERS
STRIP AND SHEET OILING EQUIPMENT
SHEET SCRUBBER AND CLEANING LINES
HOT SAWS—ROCKING AND SLIDE TYPES
HOT BEDS—COOLING BEDS—TRANSFERS
BILLET EJECTORS—PINCH ROLL STANDS
SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—Traveling and Lifting Tables
Continuous PICKLING Lines—ROLLER LEVELERS
FURNACE Charging Equipment—Furnace Pushers
Strip Steel COILERS and REELS—SCRAP BALLERS
RAILROAD Spike Forming Machines—ROLL LATHES
Sheet GALVANIZING Lines—Wire Patenting Frames
Stretcher Levelers—Angle and Shape Straighteners
Rolling Mill Tables—Gear and Individual Motor Types
DUCTILE CASTINGS (80,000 PSI.)

Machinery Built to Customer's Design and Detail Drawings

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

NICAD

MADE IN U.S.A.

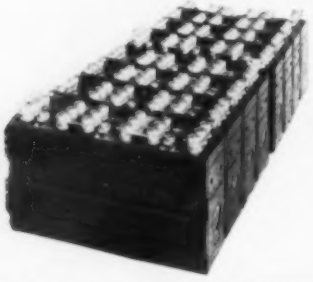
T-TYPE BATTERY

for

RAILROAD

DIESEL STARTING

2 models—THR-30, THR-44



SAVES UP TO 100 MAN HOURS PER YEAR PER LOCOMOTIVE

Because the NICAD nickel cadmium storage battery requires less maintenance you save precious man hours and, at the same time, are assured of reliable, foolproof battery service throughout its long life. The T-Type NICAD battery has an exceptionally high ampere rate of discharge at useful voltage, a vital consideration in engine-starting applications.

BATTERY TYPE	AMPERE HOURS	NUMBER OF CELLS	GROUP TRAY LENGTH A	TRAY WIDTH B	WEIGHT LBS.
THR 30	142	48	33¾"	8"	1825
THR 44	210	48	44¾"	11"	2675

THR-30—Interchangeable with 17-plate, 248 A.H. Lead Acid Batteries
THR-44—Interchangeable with 25-plate, 426 A.H. Lead Acid Batteries

NICAD IS LIGHTER, NEEDS NO ADDITIONAL SPACE

Exceptionally Long Life — *Low Internal Resistance*
Low Cost Operation — *Rugged Steel Construction*
Negligible Water Consumption — *Very Low Self-Discharge*
Uses Standard Charging Equipment

Other NICAD Applications in:

UTILITIES HEAVY AUTOMOTIVE
MARINE RAPID TRANSIT
LABORATORIES

NICAD

NICKEL CADMIUM BATTERY CORPORATION
100 Park Ave., New York 17, N. Y.
Factory—Easthampton, Mass.
Chicago Office—30 N. La Salle St.

MADE EXCLUSIVELY IN THE U.S.A.

WORM AND GEAR VALVE

▲ Worm and gear operated valves have been added to the line of Homestead-Reiser lubricated plug valves, as manufactured by Homestead Valve Manufacturing Co.

The new valves have the patented "Self-Seald" construction characteristic of all Homestead-Reiser valves; port area equivalent to 100 per cent of the area of standard pipe; are cast in semi-steel; and made in 8 in., 10 in. and 12 in. sizes.

According to the company, these valves will soon be available also in cast-steel, full-port type to be known as Figure 562 GW; and in venturi type sizes up to 14 in. In the venturi-type these valves will have face to face dimensions identical to those of like-sized series 15 wedge gate valves.

The new valves have a port area equivalent to 100 per cent of the area of standard pipe.

CONTINUOUS RECORDING

▲ Industrial Nucleonics Corp. announces the availability of a new beta ray gage for continuously recording variations in weight per unit area or thickness of a wide variety of moving sheet materials directly on the production line. Steel, aluminum, brass, rubber, plastics, and coated textile manufacturers are a few examples of those who can profit by the use of such a gage. The outstanding advantages of this beta ray gage are its ability to measure accurately and continuously to a few millionths of an inch without contacting the material being gaged, its ability to operate continuously without any standardization or recalibration by plant personnel, its insensitivity to steel composition changes, and its high degree of stability under adverse plant conditions including temperature variations, dirt, moisture, shock, and vibration.

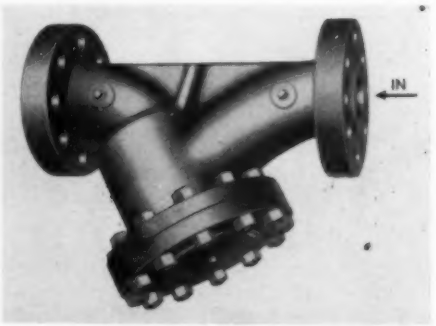
Continuous recording of variations in weight or thickness is a feature of this new gage.

This gage utilizes radioactive materials produced under the direction of the U. S. Atomic Energy Commission at the Oak Ridge Atomic Pile. The basic components of the gage are a source of beta radiation, a radiation detector, and a recording device. The material being measured is run through a gap between the source and detector, preventing a portion of the source radiation from reaching the detector in proportion to the weight per unit area of the material. Readings directly in terms of thickness can be made on materials of constant density. Gage readings are unaffected by variations in chemical or physical characteristics of the product being measured.

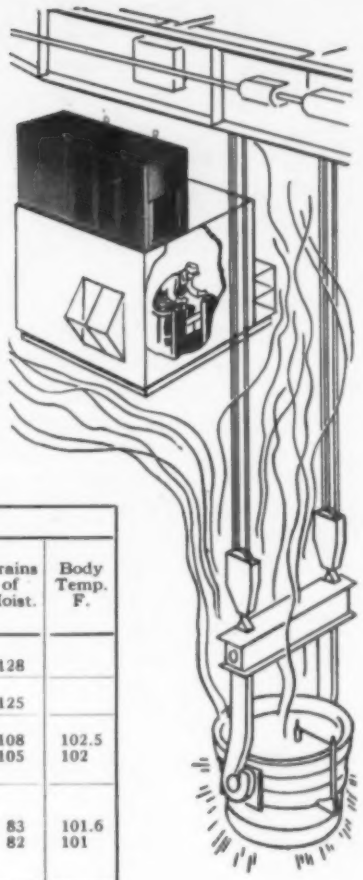
STRAINERS FOR DESCALING

▲ These strainers, manufactured by C. B. Hunt & Son, Inc., are designed to be placed in the line ahead of de-

Passage of small foreign particles are prevented by these strainers when placed ahead of descaling spray nozzles.



DRAVO CRANE CAB COOLERS



Dravo Crane Cab Coolers maintain comfortable working conditions and supply clean, pure air, under practically all atmospheric and temperature variations encountered in industry.

Not only is the health of the crane operator safeguarded but his alertness and efficiency are increased, with a consequent, substantial improvement in the overall safety and production of the department served.

Dravo Crane Cab Coolers are installed and operating on Soaking Pit, Ladle, Charging, Electric Furnace, Forge Shop, Stripper, Monocast, Reduction Plant, Fabricating Shop and Annealing cranes, and their effectiveness, dependability, and production-boosting ability have been convincingly demonstrated. Only electrical leads and connections are required for installation. Thermostat control—full automatic. Air is used for condensing.

OTHER FUNCTIONS INCLUDE:

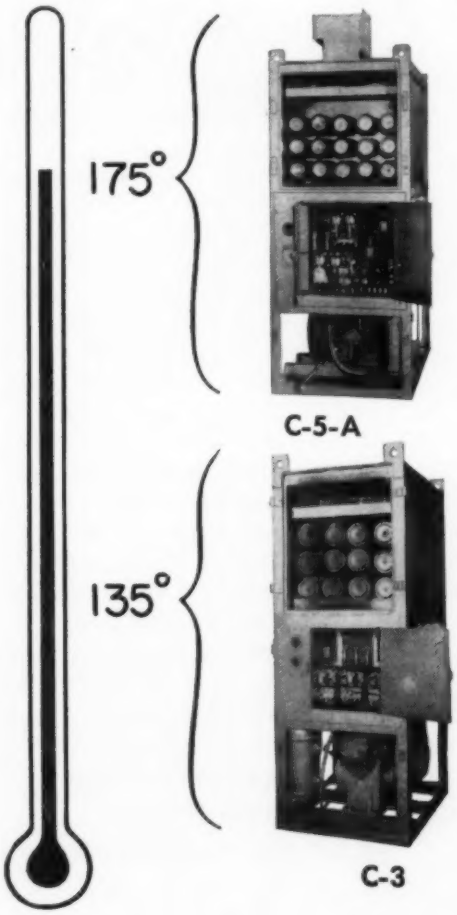
DUST AND DIRT REMOVAL. Make-up air passes through a wire mesh viscous type cleanable primary filter, is blended with return air, and the mixture is drawn through a similar secondary filter. This assures high dirt-removal efficiency.

FUME AND ODOR REMOVAL. Surfaces of activated carbon, proportioned to the capacities involved, remove almost every variety of fumes and gases ordinarily encountered in industrial operations. Tests show that CO, when present, is substantially diluted.

WINTER HEATING. Electric strip heaters are provided in sufficient quantity to temper the make-up air, and maintain 68 to 72°F in the crane cab during the normal winter heating season.

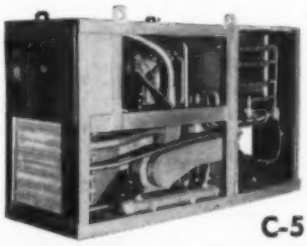
TEMPERATURE CONDITIONS

Type of Crane Operation	Amb. Temp. Dry bulb F.	Amb. Temp. Wet bulb F.	Relative Humidity %	Grains of Moist.	Body Temp. F.
Soaking Pit Coil Storage	160-170 164	94	7.8	128	
Ladle (open hearth pit side) Forging Furnaces	150-160 156	92	7	125	
Foundry (large castings) Charging (open hearth) Electric Furnace Cupola Charging	140-150 146 142	88 85	11 10	108 105	102.5 102
Ladle (small capacity) Pickling (over open vats) Aluminum Reduction Aluminum Remelting Copper Smelting Annealing Furnace	125-140 138 130	83 81	10 12	83 82	101.6 101
Cement Production Lead Production Glass Making Brass and Bronze Casting Steel and Iron Casting (small) Galvanizing Mill Vanadium Production Manganese Production	100-125 120	80	18	90	99.6



C-5-A

C-3



C-5

SUMMER COOLING. Hot weather generally creates the most difficult working conditions in crane cabs, and the cooling equipment has therefore been designed for top efficiency and maximum dependability. The temperatures ordinarily encountered in various operations are indicated on the chart. These temperatures determine the size of Dravo Crane Cab Cooler required.

DRAVO TYPE C-5 (Horizontal) and **C-5-A** (Vertical). These models are the same in capacity, and will maintain cab temperatures of 80 to 85°F when ambient temperatures range from 135 to 175°F. Two styles are offered, to meet installation space requirements. Motor hp: 5. O.D. Cabinet: C-5, 2'-6" x 6'-0" x 4'-0" H; C-5-A, 2'-7" x 3'-10" x 6'-0" H.

DRAVO TYPE C-3. Maintains cab temperatures of 80 to 85°F with ambient temperatures up to 130-135°F. Motor hp: 3. In borderline cases—the larger unit should be selected. O.D. Cabinet: 2'-2" x 2'-9" x 5'-6" H.

Dravo Crane Cab Cooler representatives are located in all principal cities. Write for the name of the one in your area.

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scaling spray nozzles. They prevent the passage of small foreign particles that could block the orifices of the spray nozzles, and consequently enable the spray nozzles to operate at full efficiency, thus preventing scale streaks, reducing product rejects, and prolonging the life of rolls, dies and other forming equipment.

The strainer consists of a series of machined bronze rings with grooved edges that are nested around a heavy slotted multi-ported high tensile bronze back-up cylinder and supported in a sturdy electric furnace cast steel housing. Foreign particles of a size that would plug the orifices of spray nozzles are filtered out by the bronze rings, which can be loosened and cleaned easily with compressed air after removing the bolted flange.

Widely used and highly endorsed. 1½ in. to 6 in. sizes for line pressures to 1500 psi.

POCKET-SIZE pH METER

▲ A revolutionary pocket-size pH meter and companion probe unit, now available for the first time, permit instant, on-the-spot pH determinations anywhere. The units are manufactured by Analytical Measurements, Inc.

Completely self-contained with batteries, in a bakelite case 3 in. × 5⅞ in. × 2½ in., this instrument is furnished, camera fashion, in an ever-ready case with novel plastic tubes of buffer and KC1 solutions. Total weight is 3 lb. Both water-proof and fungus-proof, the ever-ready case comes with a combination hand-and-shoulder strap, allowing the instrument to be slung over the shoulder or hung around the neck leaving both hands free.

Supports and beakers are completely eliminated by combining the calomel and glass electrodes with the sample holder, in a single polyethylene probe unit. This revolutionary idea of combining the sample holder with the electrodes completely protects them and requires a sample volume of only 0.5 ml.

The meter is scaled from 2 to 12 pH for easy reading, and a simple adjustment gives readings from 0 to 14. Accuracy of 0.1 pH is obtainable. Hearing-aid type batteries provide up to 1300 hours of operation. The electrometer tube, switch and input connector are sealed in a single unit to ensure freedom from high humidity

Battery-operated meter gives on-the-spot pH determinations.

difficulties. The one-knob control and continuous reading features of this instrument simplify operation for untrained personnel. Grounded samples can be directly measured because of no external power connections. The instrument and electrode are completely shielded.

Elimination of "grab samples" and trips to the laboratory by the ever-ready features of this new Pocket pH Meter and Probe Unit, open new fields for "on-the-spot" pH control.

PILOT CONTROLLED VALVE

▲ A new explosion-proof solenoid housing for use on Ross electrically operated pilot controlled valves has been announced by Ross Operating Valve Co. The cover, which can be used wherever fire and explosion hazards exist, is manufactured of cast-aluminum to Underwriters' Laboratory specifications, Class I, Group D, air break type.

Provision is made for standard conduit connection. The explosion-proof solenoid cover may be used with ¼ in. to 1¼ in. size Ross pilot operated straight-way, three-way, four-way and four-way five port models for single solenoid operation; this housing may also be used for double solenoid, momentary operation of Ross base mounted pilot controlled valves.

Solenoid housing for electrically operated pilot controlled valves.

MAGNET CHAIN

▲ S. G. Taylor Chain Co., Hammond, Ind., announces the purchase of rights for the exclusive manufacture of the new improved Downtown type frictionless magnet chain. The purchase was made from the Downtown Co., Cleveland, Ohio.

Its use in leading steel mills is said to have proved it to be more economical and to last twice as long as regular carbon steel or wrought iron magnet chains. The unique design and a special locating plate in the ring keeps the three suspension legs at 120 degree centers—they cannot gang up on the ring. Friction, twisting and gouging, the cause for excessive wear, is eliminated. Level lifts, and even distribution of load weight is assured.

This frictionless magnet chain outlasts regular carbon steel or wrought iron magnet chains.

The entire chain assembly is made from heat-treated TM alloy steel. It never requires annealing and it's extremely resistant to shock and sub-zero temperatures. It has twice the tensile strength of wrought iron chain. A 1¼ in. diameter 3-leg alloy steel chain assembly on a 65 in. magnet will lift up to 110,000 lb.

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High grade technical man with broad experience in steel plant engineering and operating supervision desires position with progressive company. For full particulars write Box 500, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

Book Reviews

▲ **"The Practice of Lubrication"** by T. C. Thomsen is a revised fourth edition published by the McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. This book contains 613 pages and 218 illustrations, 6 × 9 in., price $8.00. This engineering treatise contains 37 chapters of informative and practical material for mechanical engineers, designers and manufacturers of engines and machinery. It gives complete and concise information on the origin and nature of lubricants, purpose of engine oil additives, advances in the distillation and refining of lubricants, and the developments in physical and chemical apparatus in determining the tendency of oils to oxidize and carbonize. This book will enable simple solving of specific lubrication problems and how to make better use of lubricants in industry. Principal types of engines and machinery and typical lubrication systems employed are covered.

▲ **ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products** is a new Manual, dated December, 1950, which makes available under one cover recommended methods for measuring the volume (or weight in some cases) of petroleum and its products, and for obtaining representative samples thereof. This 132-page manual can be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $2 per copy, in heavy paper cover; $2.65, cloth cover.

▲ **"Machinability and Machining of Metals"** by Norman E. Waldman and Robert C. Gibbons has been recently published by McGraw-Hill Book Co., 330 W. 42nd Street, New York 18, N. Y., 518 pp, 6 x 9 in., price $7.50. This book is a practical manual that explains the metallurgy and machining characteristics of different metals and their alloys. It gives methods for selecting the proper material and processing this material in order to give the easiest and most satisfactory machining in the finished product. The book covers tool design, cutting speeds, feeds and type of fluid which will produce the best result.

▲ Seeking data on the preparation characteristics of coal in large reserves that might be used in making synthetic liquid fuels, the Bureau of Mines has tested a number of American coals that may be made more adaptable by mechanical cleaning, for hydrogenation according to a Bureau bulletin now available for purchase from the Superintendent of Documents. The bulletin covers washing tests on 13 coal beds previously investigated in small-scale synthetic fuel research and known to be in some measure adapted to hydrogenation.

Bulletin 495, "Preparation Characteristics of Some Coals Available for the Synthetic Liquid Fuels Industry," is sold *only* by the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., for 50 cents each. This bulletin is *not* sold by the Bureau of Mines.

▲ **NEMA Standards for Fractional-horsepower Motors, Publication No. MG2-1951** consists of excerpts from the NEMA Standards for Motors and Generators, Publication No. MG1-1949. This publication which deals with motors rated less than one horsepower. The book provides practical information concerning the construction, test, performance and manufacturing of universal and alternating—and direct— current fractional-horsepower motors. Price $2.50, NEMA 155 East 44th St, New York 17.

▲ **Ordnance Production Methods,** edited by Charles O. Herb, 542 pp, 8 by 10¾ in.; over 1000 illustrations, has been published by The Industrial Press, 140-148 Lafayette Street, New York 13, N. Y. Price, $10.

The various sections cover small arms ammunition; shells; shell fuses and boosters; cartridge cases, bombs, rockets, and torpedoes; machine guns and small arms; artillery, anti-aircraft, and naval guns; gun mounts; tanks, gun bogies, and limbers; and general ordnance manufacturing. All of the manufacturing set-ups and procedures described in these sections have been employed in industry for the manufacture of ordnance materiel. In addition to a large number of illustrations showing tooling set-ups and cutting and forming operations, there are numerous diagrams and drawings which provide specific data for the jobs described. This book should prove a valuable guide and reference work to tooling and production executives and personnel.

▲ A new 194-page publication, **"The Aluminum Data Book,"** has just been issued by Reynolds Metals Company, Louisville, Ky., to meet the demand for more factual information on aluminum alloys and mill products.

The vital facts on aluminum alloys and mill products have been condensed into a handy pocket-size manual which contains 117 tables of data on physical, chemical, and mechanical properties; standard tolerances; weights; standard sizes and production limits; as well as much fabricating data. Included are tables showing relative corrosion resistance, the action of many chemicals on aluminum, elevated and low-temperature properties, fatigue strengths, minimum bend radii, joining methods, finishes for aluminum, and much other information.

This book is a revision and enlargement of a similar book issued by Reynolds in 1948. The new book carries 32 more pages with much additional data covering new alloys not then in use. Wire bound to permit flat opening, this 6 x 9-inch book also contains 61 illustrations showing various operations in the production of aluminum. It will be sent without charge to engineers, designers, and technical men who request it on company letterhead. Address: Reynolds Metals Co., 2500 South Third Street, Louisville, Ky.

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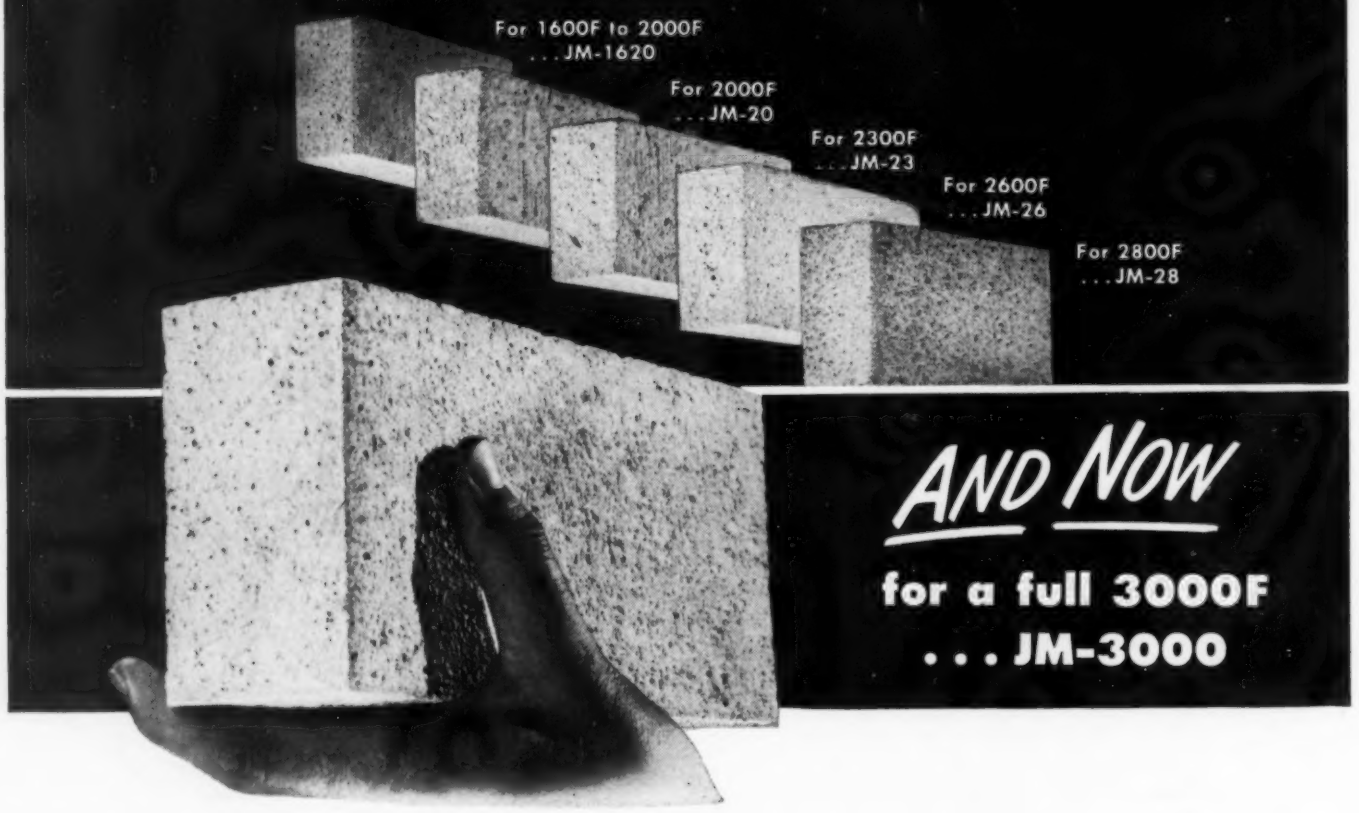

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By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.22	2.50	3.20
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

Note: Above tests are in accordance with A.S.T.M. tentative standards.

JOHNS-MANVILLE JM PRODUCTS

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Farval pays for itself quickly, many times over

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...saving production time

WITH Farval you lubricate your machinery or equipment mechanically. Farval does the job quickly and dependably.

Any type of bearing surface, enclosed or open, can be Farval-lubricated with grease or oil. Measured charges of lubricant are metered to each bearing through the unique Dualine Valve, delivered under pressure from a central reservoir, either by a manually operated pump or one actuated by an automatic time-clock mechanism.

Farval is not a new idea. It has proved its value in service over a 23-year period, protecting millions of bearings in every phase of industry—in manufacturing plants, mining and quarrying operations, transportation—wherever there are bearings that have to be lubricated. Thousands of installations on mills, presses, conveyors, cranes, engines and other industrial equipment provide records of money saved. Savings take four forms:

1. Labor saving—Farval eliminates hand oilers. Minimum attention only is required—to inspect system, refill lubricant reservoirs, etc.

2. Lubricant saving—Correct amounts are used without waste, frequently reducing oil or grease consumption as much as 75%.

3. Bearing expense saving—No more burned out or damaged bearings with Farval protection. Expense of replacement eliminated.

4. Production time saving—Farval lubricates while equipment is running. No shutting down to oil. No taking a machine out of production to repair or replace bearings.

In short, savings are so positive that you soon recover the entire cost of a Farval system—and savings continue as extra dividends.

If you want figures on savings possible with Farval on the types of machines you operate, just write us. Tell us what equipment you have and ask for Bulletin 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

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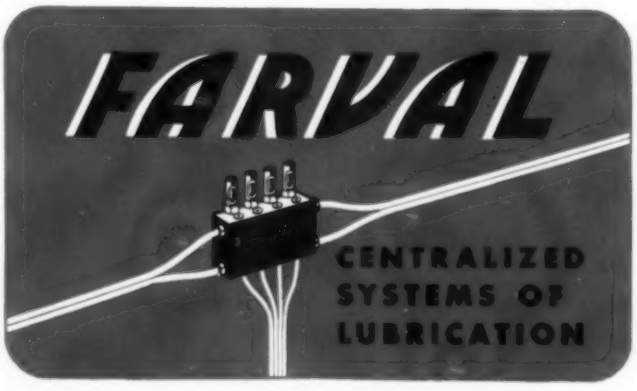
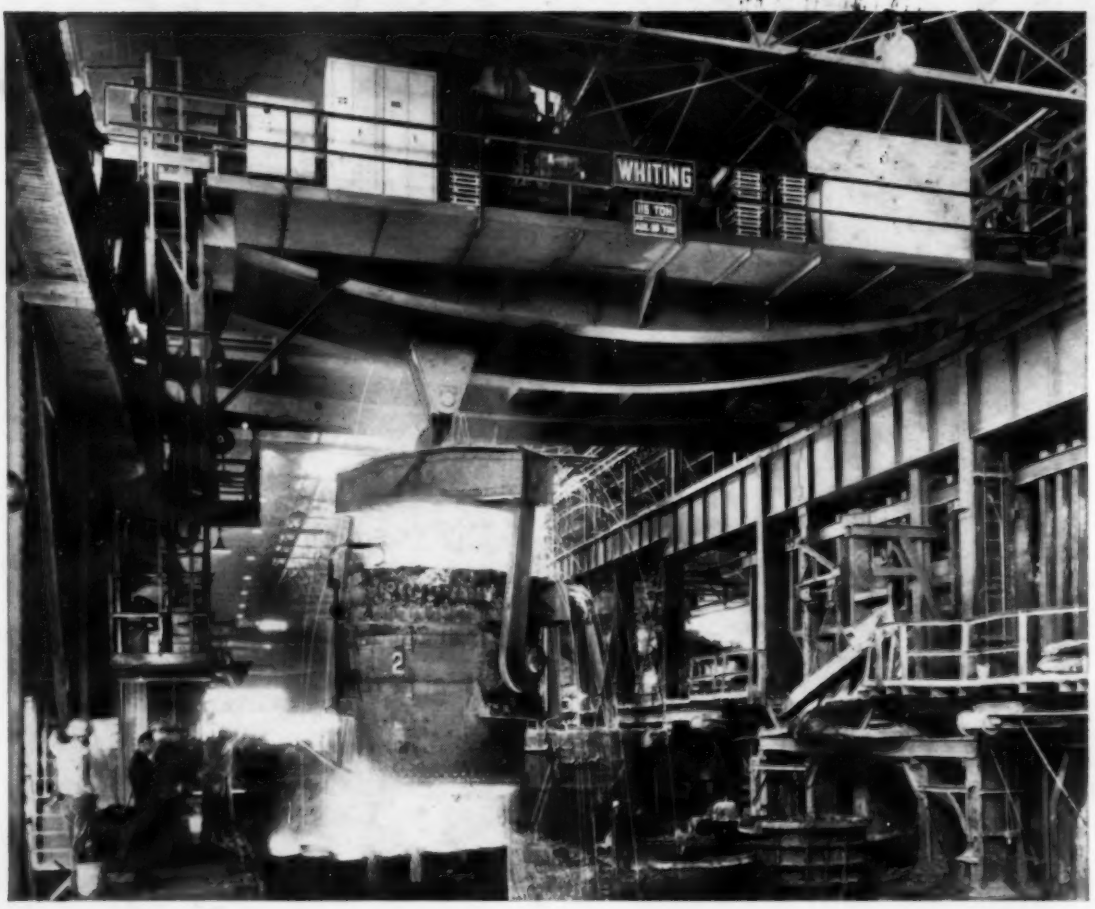
FARVAL—*Studies in Centralized Lubrication*
No. 122



CO-ORDINATED

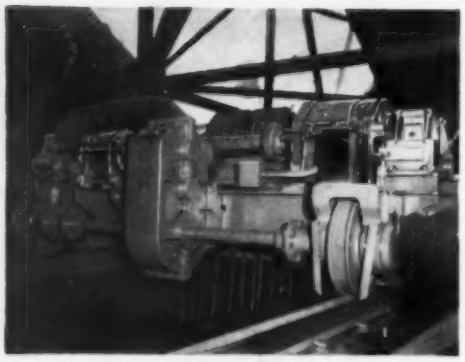
D-C CRANE DRIVES

Teeming is easy with new G-E d-c control which permits faster, more accurate positioning because of slow first-point lowering, no downward drift on first hoisting point.



"Heats" poured faster!

New G-E crane-hoist control—teamed with heavy-duty motors and fast-acting brake—permits safer, more accurate handling of new 115-ton ladle crane



Close-up of main trolley shows (at right) the 65-hp main hoist motor with newly designed G-E d-c magnetic brake for quick, accurate stops. At left is the 19-hp G-E trolley motor. Both motors are MD-600's—toughest G-E mill motors ever built.

Providing safer, more accurate control of this 115-ton ladle crane is the new G-E d-c crane control . . . control which has been *job-tested* on more than 50 tough-duty steel-mill installations. Here are a few of its features:

- Facilitates pouring by eliminating downward drift on first hoisting point.
- Slow light-load speed eliminates jarring of ladle when engaging hooks for pickup.
- Protects against cycling or pumping in limit-switch zone.
- Permits more accurate positioning because of slow first-point lowering.

Co-ordinated with the control are G-E MD-600 mill motors built to take the severe reversing duty required, and new fast-acting G-E d-c magnetic brakes for close jogging and precision spotting.

Whatever *your* crane drive problem, let a G-E steel-mill specialist help you reach a successful solution. For more data on G-E d-c crane drives, send for Bulletin GEA-5408. *General Electric Company, Schenectady 5, N. Y.*

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659-80